Hanzehogeschool Groningen
University of Applied Sciences

European Master in Renewable Energy (MSc)

Short Module Descriptions Handbook
Specialisation semester SFS 2019-2020

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1. Short Module Descriptions Handbook

1.1. Introduction

The European Master Renewable Energy (EMRE) program is defined by ***Program Learning Outcomes*** and ***Module Learning Outcomes contained in (learning) Modules.*** An overview of the modules of EMRE is given below. The modules are divided in CORE Modules (F1-F6), Specialization Semester modules and Thesis Module.

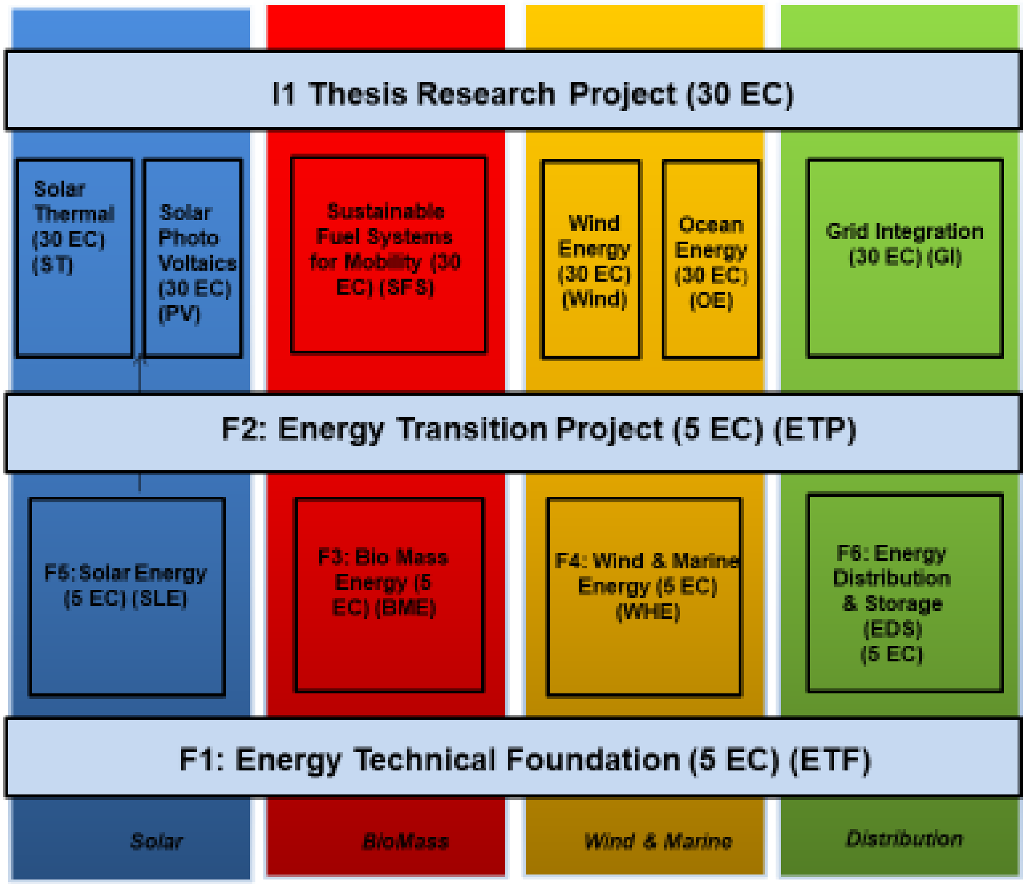

Figure 1: Overview of the EMRE Modules

1.2. Programme Learning Outcomes

EMRE at Hanze UAS defines the following program learning outcomes.

E2.1
(A) Academic learning outcomes: good and applicable knowledge of, and skills in, analytical and research methodology relevant for current and future renewable energy sources; being able to conduct applied research, which combines scientific rigor and practical impact, in complex professional ‘real life’ situations. M.Sc.-graduates will be

reflective professionals, with a **sound grasp of research methodology**: they will be competent to conduct applied scientific research in order to implement fundamental research insights in renewable energy innovations. The M.Sc.-graduate is competent to use a range of applied research methods and techniques **independently**:

- **a.** to formulate a problem definition, employ specific research and analysis methods and plan and conduct research on real-life non-routine problems.
- **b.** to translate a practical problem into questions in terms of a conceptual model, to collect relevant data and to translate the outcomes of the model into answers to the original problem.
- **c.** to apply appropriate scientific methods and techniques, mathematics, economics and other sciences in energy systems design.
- **d.** to communicate findings in both written and oral form in English to the problem owner and other relevant stakeholders.
- **e.** to display a reflective attitude (investigative, critical) towards the possibilities and limitations of the scientific methods used and the development of a body of knowledge and, based on that attitude, make meaningful contributions to the energy debate.

E2.2

(B) Application-oriented learning outcomes: good and **applicable** knowledge of multiple renewable energy technologies, and a higher level in at least one particular renewable energy technology. Learning attention will focus on solar, water, biomass and wind energy in the context of the analysis and/or **originality** of **design** of near energy neutral systems (as little energy loss as possible). The MSc.-graduate is competent in:

- **a.** multiple renewable energy technologies and – depending on the specialisation chosen by the student – specialist in at least one renewable energy technology.
- **b.** integrating renewable energy sources (wind, solar [photovoltaic, thermal], water, biomass energy) into a flexible, distributed energy system.
- **c.** applying the principles of integrated storage techniques.
- **d.** analysing and improving the energy efficiency of production chains (implementing innovations).

E2.3

(C) Context-oriented learning outcomes: basic understanding of issues in energy strategy and politics at different **levels of context** (local, regional, national, global).
The MSc-graduate is competent in:

- **a.** applying knowledge and insights of the principles of a range of renewable energy systems for optimal energy conversion.
- **b.** **designing a (range of)** renewable energy **system(s)** for optimal energy conversion at a given location and for particular applications.
- **c.** critically appraising codes of practice relevant to renewable energy systems.
- **d.** analysing economic and sustainability aspects of renewable energy systems as well as technological considerations.
- **e.** statistically assessing renewable energy resources at a specific location given appropriate data.

E2.4

(D) Integrative learning outcomes: good ability to **integrate** technical knowledge and skills with technological, strategic, social and economic issues; ability to **handle complexity**.
The MSc graduate is competent in:

a. using appropriate mathematical methods for modelling and analysing engineering problems relevant to renewable energy systems.
b. using knowledge and understanding of the socio-economic effects of introducing and using relevant technologies.
c. Making an economic evaluation of the profitability and competiveness of renewable energy projects.

E1.1
(E) Communication learning outcomes: ability to communicate **appropriately** and perform efficiently in international, **multidisciplinary teams**.
The MSc graduate is competent in:

a. carrying out tasks in a project environment.
b. participating effectively in an international, multidisciplinary team.
c. communicating effectively orally, visually and in writing at an appropriate level (in English) to clients and stakeholders.
d. communicating the link between technological projects and strategic objectives, to the management and other relevant stakeholders.

E1.2
(F) Professional development learning outcomes: ability to **learn independently** and **reflect** on oneself in a professional context.
The MSc graduate is competent in:

a. staying abreast of relevant (inter)national developments, trends and ideas in society, policy, and professional practice and to translating, developing and introducing these in an innovative manner to improve professional practice.
b. managing his or her own learning process and sharing expertise with peers and other experts in professional practice.

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

2. Sustainable Fuel Systems for Mobility – Groningen

2.1. G1 Physics and Fuels

Institute for Engineering **Subject:** *European MSc in Renewable Energy* *Summer Term*	**Category:** - *MSc Module* **Degree award:** - *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *G1/Physics and Fuels*	
Duration: 1 semester **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 2nd semester*	**Type of program:** Lecture, Laboratory, Excursion **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hours
Person responsible for the program: Ir. G. Kuiken	**Person responsible for this module:** Dr ir. J. Bekkering
Alternative person(s) responsible for this module: Dr. A. Perl	**Examiner(s):** All listed persons

Objective of the module / skills:

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

E2.1.c.1 states and state transfer
E2.1.c.2 combustion, heat transfer and fluid mechanics
E2.2.a.1 gaseous energy carriers: hydrogen, biogas, green gas, CNG, CBG
E2.2.a.2 liquid energy carriers: gas-to-liquid, ethanol, liquefied hydrogen, LNG
E2.2.c.1 storage: parameters and technologies

And is able to:

E2.4.a.1 model processes for fuel production with a focus on downstream
E1.1.c.1 present an overview of the processes

Content of the module:

Theory (4 EC):

- ideal vs real gas, equations of state, compressibility
- heat transfer
- cryogenics (Joule-Thomson)
- combustion technology (incl. engines and emissions)
- fuels (properties/flow/storage)
- additives
- compression
- storage

Lab (1 EC):

- Aspen Plus

Suggested reading

- Perl A, Reader, 2019 (available on Blackboard)
- Çengel, Y. A. & Boles, M. A. Thermodynamics: an engineering approach. (McGraw-Hill Education, 2015)
- Çengel, Y. A., Ghajar, A. J. & Kanoğlu, M. Heat and mass transfer : fundamentals & applications. (McGraw-Hill Education, 2016).
- Bekkering J, Readers, 2018 (available on Blackboard)

Comments:

-

Weblink:

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Prerequisites for admission*:*

-

Helpful previous knowledge:

-

Associated with the module(s):

-

Maximum number of students / selection criteria:

-

Types of examinations:

Written Exam (4 EC)

Report (1 EC)

Examination periods:

Feb-March

Registration procedure:

OSIRIS: ZWVH19PAF

2.2. G2 Bio Energy Conversion

Institute for Engineering **Subject:** *European MSc in Renewable Energy* *Summer Term*	**Category:** - *MSc Module* **Degree award:** - *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: G2/*Biochemical & Thermochemical Conversion (BEC)*	
Duration: 1 semester **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 2nd semester*	**Type of program:** Lecture, Laboratory, Excursion, Tutorial **Language:** English **Attainable credit points:** 10 EC **Workload:** 280 hours **Required attendance:** 96 hours
Person responsible for the program: Ir. G. Kuiken	**Person responsible for this module:** Dr. A. Perl
Alternative person(s) responsible for this module: Dr. C. Visser, Dr. M. Cieplik (ECN), dr. F. Faber	**Examiner(s):** All listed Persons

Objective of the module / skills:
To have demonstrated knowledge and understanding of:

- Chemistry to calculate the thermodynamic outcome of various (bio)chemical reactions
- Thermodynamic and kinetic basics of different biochemical and thermochemical conversion technologies
- Broad variety of (lignocellulosic) biomass feedstocks and energy carriers, based on their origin (woody/non-woody), chemical composition as well as physical properties
- Distinguishing the many choices in biological and thermochemical conversion processes
- The practical challenges of various biochemical conversion technologies (fermentation/digestion) and based on various technical designs (batch/continuous), including general characteristics and sub-processes
- The practical challenges of various thermochemical conversion technologies (pyrolysis/gasification/combustion) and based on various technical designs (fixed/fluidized bed/pulverized fuel), including general characteristics in terms of scales, emissions and system efficiencies
- Unit operations that are required for a given biochemical and thermochemical process
- Environmental score/impact of producing biofuels

To be able to

- Make mass and energy balances in biological and thermochemical conversion processes
- Set up a biological conversion experiment (e.g. anaerobic digestion or photo-bioreactors)
- Design a biofuel plant including the streams, processes and stakeholders
- Model a biofuel production plant and calculate energy conversion efficiencies
- Recognize different types of biomass feedstock and upgraded biomass energy carriers
- Select a suitable thermochemical conversion process, based on biomass/feedstock chemical composition and physical properties
- Contribute to discussions with experts
- Demonstrate knowledge of the various types of biofuels and their capabilities/suitability to particular mobility applications and engines;
- Demonstrate understanding of end-use specifications (including purity, storage) for biofuels and how these relate to the processing of the biofuels from raw materials;
- Perform material and energy balances over sub-processes and processes involved in a bio-refinery using Aspen Plus;
- Model a biofuel production plant using Aspen Plus and calculate energy conversion efficiencies (and other relevant factors);
- Evaluate the business case of a modeled production facility which meets appropriate specifications for the produce

Content of the module:

Biochemical Conversion:

Basic biochemistry

- Molecule concept (Basic chemistry)
- Thermodynamics (calculations on energy and work of chemical reactions)
- Metabolism: various metabolic processes related to biofuel production
- Photosynthesis: energy efficiencies and energy content
- Biomass: sources and availability, composition

Biochemical conversion technologies

- Types of biofuels (mainly bioethanol, biomethane, biodiesel)
- Conversion techniques, mainly the following 3, but other techniques/biofuels will be dealt with as well
  - Anaerobic digestion (biomethane)

- Fermentation (bioethanol)
- Transesterification (biodiesel)

- Pretreatment technologies (steps and implications)
- LCA (explanation and environmental impact/score different biofuels)
- Industry (description bioethanol power plant 1st and 2nd generation feedstock Brazil)
- New (industrial) technologies in biofuel productions
- Modelling: calculations on microbial growth and biofuel production
- Bioreactor design and operation, bio-methane, bio-ethanol and algal oils (foto bioreactors)
- Economy: modelling and LCA analysis for cost effect biofuel production The use of biofuels
- Biorefinery and upgrading
- End-use specifications (combustion properties, energy density, storage properties, logistics)
- Mobility
- Fuel suitability
- Engine types
- E-bike; hybrid car, other
- Infrastructure
- Energy balance
- Evaluation business cases

Thermochemical conversion:

Basic properties of biomass feedstocks- and -derived energy carriers

- Organic and inorganic compositions of raw and mechanically/thermally upgraded lignocellulosic biomass
- Physical properties of raw and mechanically/thermally upgraded lignocellulosic biomass energy carriers
- Suitability of different biomass types for specific thermochemical processes

Basics of thermochemical conversion processes:

- Torrefaction
  - dry/wet
- Pyrolysis
  - fast/slow
- Gasification
  - direct/indirect
  - producer gas purification and upgrading to various qualities
- Combustion
  - direct/air-staged
  - for heat and/or power generation
- Typical temperature levels, scales and overall mass/energy efficiencies
- Compositions of typical flue-, process- and producer-gasses, including by-products, impurities and emissions

Specific technology solutions for pyrolysis, gasification and combustion:

- Grate-fired/fixed/moving bed systems
- Fluidised-bed systems
- Pulverised-fuel systems
- Typical technical bottlenecks and solutions to overcome those for each specific technology solution
- The technological maturity and the role in the current and (potential) future heat and power market.

The Production and Use of Biofuels: An Aspen Programming Assignment

Topics

- Introduction to bio refinery
- Aspen computer Lab unit operations (1), utilities & coupling Unit Ops (2), closing loops &

optimization (3,4), business case tutorial(5)

- Biofuels and mobility
- Biofuels applicability
- Biofuels Properties
- Biofuel Purity, Storage and End Use

Suggested reading:

- W de Jong & JR van Ommen (Eds.), “Biomass as a sustainable energy source for the future”, Hoboken, NJ, USA: Wiley & Sons, Inc.(2014)
- Further reading material to be announced at the beginning of the lecture periodTo be announced at the beginning of the lecture period

Comments:

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Weblink:

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Prerequisites for admission:

-

Helpful previous knowledge:

-

Associated with the module(s):

-

Maximum number of students / selection criteria:

-

Types of examinations:

- Written Exam Basic & Biochemical Conversion (3 EC)
- Written Exam Thermochemical Conversion (2 EC)
- Assignment Lab Biofuels (BioEthanol making) (2 EC)
- Assignment Aspen Programming (3 EC)

The course is ultimately evaluated by means of a report evaluating the model and business case of a biofuel production facility or (whole) bio-refinery unit modeled by the student in Aspen Plus. The report should include a background on the biofuel produced and it’s (most significant) mobility application(s), the relevant end-use specifications of the product, the results of the model (including relevant material and energy balances), and a detailed economic evaluation of the model including a Discounted Cash Flow Rate of Return and determination of the break-even point.

Examination periods:

- May/June

Registration procedure:

OSIRIS: ZWVH18BCC (BioChemical Conversion); ZWVH18TCC (ThermoChemical Conversion); ZWVH15UB (Lab Biofuels); ZWVH15RAP (Assignment ASPEN model)

2.3. G3 Power-to-Hydrogen

Institute for Engineering **Subject:** *European MSc in Renewable Energy* *Summer Term*	**Category:** *- MSc Module* **Degree award:** *- MSc*
Emphases: -	**Sections:** -
Module reference number/Title: G3/*Power-to-Hydrogen (P2H)*	
Duration: 1 semester **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 2nd semester*	**Type of program:** Lecture, Laboratory, Tutorials **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hours
Person responsible for the program: Ir. G. Kuiken	**Person responsible for this module:** Dr. ir. J. Bekkering
Alternative person(s) responsible for this module: Dr. A. Perl	**Examiner(s):** All listed Persons
Objective of the module / skills: By completing the module the student demonstrates knowledge and understanding of: *E2.2.a.1 theoretical constructs and scientific frameworks relevant to power-to-hydrogen* *E2.2.a.2 main sources of energy dissipation in electrolysers and fuel cells* *E2.2.b.1 power-to-hydrogen value chains for mobility* And is able to: *E2.1.c.1 design scientific experiments to analyse the performance of electrolysers* *E2.3.e.1 define and measure the energy efficiency of electrolysers* *E1.1.c.1 archive and communicate effectively experimental results*	

Content of the module:
Theory (3 EC):
- Overview power-to-hydrogen supply chain
- electrochemistry basics
- batteries
- electrolysis: theory and electrolyser design
- fuel cells: theory and design

Experiments (2 EC):
- Electrolyser measurements
- Adsorption (storage) measurements

Suggested reading:
- Godula-Jopek A, Hydrogen production by electrolysis, Wiley-VCH, Weinheim Germany, 2015 (e-book available in Hanze library)
- Revankar S, Majumdar P, Fuel Cells – Principles, Design and Analysis, CRC Press, ISBN 9781420089684, 2014 (hard copy available in Hanze library)
- Fardo SW, Dale PR., *Industrial Process Control Systems*, 2nd Edition, The Fairmont Press, 2009 (ebook in the library available)

Comments:
-

Weblink:
-

Prerequisites for admission:
-

Helpful previous knowledge:
-

Associated with the module(s):
-

Maximum number of students / selection criteria:
-

Types of examinations:
- Written Exam (3 EC)
- Report (2 EC)

Examination periods:
- March

Registration procedure:
OSIRIS: ZWVH19P2U

2.4. G4 Sustainable Fuel System Design

Institute for Engineering **Subject:** *European MSc in Renewable Energy* *Summer Term*	**Category:** - *MSc Module* **Degree award:** - *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: G4/*Sustainable Fuel System Design (SFD)*	
Duration: 1 semester **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 2nd semester*	**Type of program:** Lecture, Laboratory, Tutorials **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hours
Person responsible for the program: Ir. G. Kuiken	**Person responsible for this module:** Dr. ir. J. Bekkering
Alternative person(s) responsible for this module: Dr. E.J. Hengeveld	**Examiner(s):** All listed Persons
Objective of the module / skills: By completing the module the student demonstrates knowledge and understanding of: *E2.1.a.1. problem definition in supply chain analysis* *E2.1.b.1 critical analysis of relevant literature and empirical background materials* And is able to: *E2.3.a.1 formulate models of energy systems, using methods and techniques for energy systems* *E2.3.d.1 select an appropriate technique for modelling given energy problems, such as Linear Programming (LP) and Mixed Integer Linear Programming techniques (MILP)* *E2.3.d.2 explain the underlying assumptions and limitations* *E2.4.a.1 implement these models* *E1.1.c.1 systematic report research question, methods, results, discussion and conclusions*	

Content of the module:

- Supply chain concepts: Material Flow Analysis, Life Cycle Cost of Energy
- Sustainability: concepts, Primary Energy Input Output Ratio, greenhouse gas emission saving, well-to-wheel analysis (WTT, TTW, WTW)
- Theory on LP, MILP, sensitivity analysis, Monte Carlo
- MATLAB modeling

Suggested reading:

- Bekkering, Readers, 2016 (available on Blackboard)
- Bekkering J, Hengeveld EJ, Gemert WJT van, Broekhuis AA, *Will implementation of green gas into the gas supply be feasible in the future?*, Applied Energy 2015, 140: 409-417
- Montoya J, Hengeveld EJ, Reader, 2019 (available on Blackboard)
- Hu TC, Kahng AB, *Linear and Integer Programming Made Easy*, Springer, 2016, ISBN 978-3-319-24001-5 (e-book available in Hanze library)

Comments:

-

Weblink:

-

Prerequisites for admission:

-

Helpful previous knowledge:

-

Associated with the module(s):

-

Maximum number of students / selection criteria:

-

Types of examinations:

- Assignment 1 (2 EC) : Sustainable supply chains (report)
- Assignment 2 (3 EC) : LP (report)

Examination periods:

- April

Registration procedure:

OSIRIS: ZWVH19SFSD

2.5. G5 New Business Development

Institute for Engineering **Subject:** *European MSc in Renewable Energy* *Summer Term*	**Category:** - *MSc Module* **Degree award:** - *MSc*
Emphases: -	**Sections:** -
Module reference number/Title: *New Business*	
Duration: 1 semester **Cycle:** once a year **Type of module:** mandatory **Level:** MM (MSc module) *This module should be taken in 2nd semester*	**Type of program:** Lecture, Laboratory, Excursion, Tutorials **Language:** English **Attainable credit points:** 5 EC **Workload:** 140 hours **Required attendance:** 50 hours
Person responsible for the program: Ir. G. Kuiken	**Person responsible for this module:** Dr. ir. JJ. Aué
Alternative person(s) responsible for this module: Dr. ir. M. van Steenis	**Examiner(s):** All listed persons

Objective of the module / skills:

To be able to:

1. Judge the technical feasibility of bio-fuel facilities
2. Assess the sustainability of the process

To have demonstrated knowledge and understanding of:

- Bio- fuel concepts
- Business model canvas / business cases
- Life cycle analysis
- Developing new value chains

To be able

- Writing and pitching a business plan

Content of the module:

Different sustainable fuel systems can be developed, each with its own characteristics and thus its own market, depending on the requirements that certain consumer segments will have.

In this module we will study two sustainable fuels systems based on gaseous sustainable fuels: bioLNG and hydrogen. Reference systems can for example be electric or fossil fuel based transport.

The final goal of this module is to investigate and present one of these sustainable fuel systems in the form of a business concept, including advantages and disadvantages when compared to other fuel systems.

To be able to develop such a concept, the following program has been developed:

1. Introduction on business models and recap LCA
- Chain analysis:
  o Chain efficiency
  o SCBA
  o Financial analysis
- Stakeholder involvement
- Business Models
2. Introduction on two sustainable fuel chains
- Bio LNG
- Hydrogen
3. Value chain new business development
4. Business tools
- Business Model Canvas
- Financial parameters (ROI, NVP, CAPEX, OPEX)
- Partner analysis
- Competition analysis
5. Business development plan based on the tool from point 2 and 3 for one of the cases presented
6. Presentation and defense of own concepts based on one of the cases presented
- Pitch (who, what, how , why)
- Consultative selling technique SPIN
- Pyramid principle reasoning

Suggested reading:

Starting out on social return of investment: http://www.socialvalueuk.org/app/uploads/2016/03/Starting%20Out%20Guide.pdf.

Maus, 2013. Sustainable fuel – Fantasy. Cover story Innovation & Sustainability. Autotechreview.com

- Borne, 2015. Explore policies to stimulate Bio LNG using a social cost benefit analysis.
- Betralmello et al, 2013. Why New business models matter for green growth
- Bolat et al, 2014 , Hydrogen supply chain architecture for bottom-up energy systems models.

Part 1 and 2 : Developing pathways wulf et al , 2018 , life cycle assessment hydrogen transport and distribution

Bhandari et al, 2014 , lca hydrogen production review.

Technology Roadmap , Hydrogen and Fuel Cell (and annex) IEA 2015Element Energy , 2018, Hydrogen Supply Chain Overview https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760479/H2_supply_chain_evidence_-_publication_version.pdf

Sebastian Schiebahn a.o., , 2015 Power to Gas: Technological overview, systems analysis and economic assessment for a case study in Germany.

Tractebel and Hinicio , 2017, study on early business cases for h2 in energy storage and more broadly power to h2 applications final report, FCH-JU by Well-to-wheel analysis for electric, diesel and hydrogen traction for railways , Andreas Hoffrichter a,⇑ , Arnold R. Miller b , Stuart Hillmansen a , Clive Roberts a

- Dai et al, 2015. Gasification of Woody Biomass.
- Zhang et al, 2018. Life cycle assessment and optimization analysis of different LNG usage scenarios.
- Kumar et al, 2015. LNG: An eco-friendly cryogenic fuel for sustainable development.
- Moreno – Benito et al, 2014 , Towards a sustainable hydrogen economy: Optimisation- based framework for hydrogen infrastructure development

Business makeover website http://www.businessmakeover.eu

Barbara Minto, the pyramid principle (Hanze Library or online).

ENTSO-E Guideline for Cost Benefit Analysis of Grid Development Projects, ENTSOE, 2018

Guide to Cost-Benefit Analysis of Investment Projects, European union, 2015

Lazard levelized cost of energy 2018

Tantau et al , 2018, Business Models for Renewable Energy Initiatives : Emerging Research and Opportunities. http://search.ebscohost.com.nlhhg.idm.oclc.org/login.aspx?direct=true&db=nlebk&AN=1559769&site=ehost-live

Future cost and performance of water electrolysis: An expert elicitation study O. Schmidt a,b,*, A. Gambhir a, I. Staffell b, A. Hawkes c, J. Nelson a, S. Few a

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	Activity	Items graded	deadline	Grade	Second chance
LCA	individual	2 page summary of an LCA focused on well-2-wheel efficiency and CO2 emissions	Academic level (application of theory, insight in specific case, analytical skills) -Product/report (originality/creativity, feasibility, completeness) -Process (result oriented, autonomy, reflection) -Presentation (written LCA summary)	June	grade 1 - 10	Extra 2 page
Business plan Canvas Business model	individual	a written canvas business model of the students his/her own plan, must include a separate financial, partner and competition analysis. 10 pages	- Academic level (application of theory, insight in specific case, analytical skills) -Product/report (orginality/creativity, feasibility, completeness) -Process (result oriented, autonomy, reflection) -Presentation (written summary)	June	grade 1-10	new canvas business model
Elevator Pitch	Individual	Pitch 4 minutes, 2 page summary of the 2 minutes pitch and possible SPIN strategy	- Academic level (application of theory, insight in specific case, analytical skills) -Process (result oriented, autonomy, reflection) -Presentation (and written summary)	June	ranking the pitches by the expert and audience nr 1 grade 10 nr 2 – nr 3 9 nr 4- nr 5 8 nr 6- nr 7 7 summary grade 1-10	New summary

Examination periods:

- June

Registration procedure:
OSIRIS: ZWVH18NBD

3.Hanze UAS SFS Exam Table 2019-2020

European Master in Renewable Energy Specialisation Semester 2 (SFS) (Hanze UAS)					2019-2020				Versie 28-05-2019
Module G1 Physics and Fuels	**Module Code**	**EC**	**Exam**	**Written Ex**	**Assessment**			**1st examiner**	**2nd Examiner**
Physics and Fuels	ZWVH19PAF	**5**							
Theory	80%	*4*	**W**	**2,5**	Written Exam	2-3-2020	31-3-2020	J. Bekkering	A. Perl
Lab	20%	*1*	O		Lab Report			J. Bekkering	A. Perl
Module G2 Bio Energy Conversion									
Bio Energy Conversion		**10**							
Theory BioChemical Conversion ic Basics	**ZWVH18BCC**	*3*	**W**	**2**	Written Exam	4-5-2020	20-5-2020	C. Visser	A. Perl
Theory ThermoChemical Conversion	**ZWVH18TCC**	*2*	**W**	**1,5**	Written Exam	25-5-2020	10-6-2020	M. Cieplik	C. Visser
Lab BioFuels* **	ZWVH15UB	*2*	O		Lab Report	4-5-2020		F. Faber	A. Perl
Assignment Aspen Model* **	ZWVH15RAP	*3*	O		Aspen Design Model	22-5-2020		A. Perl	F. Faber
Module G3 Power2Hydrogen									
**Power2Hydrogen * ** **	ZWVH19P2U	**5**							
Theory	60%	*3*	**W**	**2**	Written Exam	16-3-2020	20-4-2020	A. Perl	J. Bekkering
Experiments	40%	*2*	O		Report	3-4-2020		A. Perl	J. Bekkering
Module G4 Sustainable Fuel Systems Design									
**Sustainable Fuel Systems Design* ** **	ZWVH19SFSD	**5**							
Assignment 1	40%	*2*	O		Report	23-3-2020		J. Bekkering	E.J. Hengeveld
Assignment 2	60%	*3*	O		Report	2-4-2020		E.J. Hengeveld	J. Bekkering
Module G5 New Business Development									
Business Plan Report* **	ZWVH18NBD	**5**	O		Report	11-6-2020		Jj Aué	M. van Steenis
**Report may also include a presentation (pitch)*	*** always includes Individual part and may be a Group part*								

European Master in Renewable Energy Specialisation Semester 2 (partner Universities)									
		EC	Ex						
	Code		W/O		Assessment			1st examiner	2nd Examiner
Specialisation Photovoltaics (Northumbria)	ZWVH2SPV	30	O						
Specialisation Wind Energy (Athens)	ZWVH2SWE	30	O						
Specialisation Grid Integration (Zaragoza)	ZWVH2SGI	30	O						
Specialisation Solar Thermal (Perpignan)	ZWVH2SST	30	O						
Specialisation Ocean Energy (Lisbon)	ZWVH2SOE	30	O						
European Master in Renwable Energy Thesis Project Semester 3									
Thesis Project		EC	Ex						
	Code		W/O					1st examiner	2nd Examiner
Thesis Project	ZWVH17THP	30	O						

Contact data
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