Module handbook

REM M.Sc. Renewable Energy Engineering and Management

Academic year 2014/2015

State of 16.10.2014

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Module handbook
Master of Science
Renewable Energy Engineering and Management

1. Introductory comments

According to § 14 of the examination regulation of the MSc Renewable Energy Engineering and Management a module handbook has to be provided. The module handbook refers to the academic year and gives information about the time schedule, type and scope of the module related courses and examinations.

The MSc Renewable Energy Engineering and Management is a two-year course. In the first part the time schedule for the students in their respective semester (first or third semester, second or fourth semester) is given. In the second part the module descriptions (listed accordingly to the time schedule given in the first part) inform about the contents and course prerequisites of the individual modules.

The module handbook is available on the website of the MSc Renewable Energy Engineering and Management (www.rem.uni-freiburg.de). Thus students have access to the module handbook before and during their studies.

2. Schedule

	Winter term 2014/15 Third Semester																									
	October			November						December				January				February				March					
CW				43	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11	12	13	CW
				20.10 – 07.11.			10.11. - 28.11.			01.12. – 19.12.			- 6.01.	07.01. – 23.01.				26.01. – 13.02.			16.02. - 06.03.						
REM (3rd Sem.)				Module **Internship**			Module **Student Organized Event**			Module **Management II**			Christmas Break	Module **Case study**				Module **Elective II**			Module **Project**						REM (3rd Sem.)
				Becker			**Becker**			**Hanewinkel**				**Becker**				**Becker, Reindl, Wittwer**			**Becker**						
				Student Organized Event																							

	Summer term 2015 – Second Semester																							
		April			May				June					July				August					
CW			18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	...		CW
			13.04 –30.04.			04.05.- 22.05.			25.5-30.5	01.06. - 19.06.			22.06 – 10.07.			13.07 - 31.07.			03.08 -				
REM (2nd Sem.)			Module **Generation and Distribution of Energy**			Module **Manage-ment I**			**B**	Module **Research Skills**			Module **Society & Economy**			Module **Elective Bioenergy I, Wind energy**			Module **Internship**					REM (2nd Sem.)
			Reindl			**Hanewinkel**				**Baumgärtner**			**Baumgärtner**			**Ragwitz, Jäger**			**N.N.**					

	Winter term 2014/15 First Semester																									
	October			November					December				January				February			March						
CW				43	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11	12	13	CW
	16.-17.10.			20.10 – 19.12.									- 6.01.	07.01–23.01.				26.01. – 13.02.			23.02. – 13.03.					
REM (1st Sem.)	Introductionary days			Module **Energy & Sustainable Development**									Christmas Break	Module **Natural Resources and Conversion Technologies**							Module **Climate & Energy Policy**					REM (1st Sem.)
				Schmidt																						
				Module **Scientific Framework for REM**																						
				Baumgärtner, Reindl										**N.N.**							**Ragwitz**					

3. Module descriptions

3.1. Winter term 2014/2015 – first semester

- **Energy and sustainable development**
- **Scientific Framework for REM**
- **Natural resources and Conversion Technologies**
- **Climate and energy policy**

3.2. Winter term 2014/2015 – third semester

- **Internship**
- **Student Organized Event**
- **Management II**
- **Integrated Case Study**
- **Elective II**
- **Project**

3.3. Summer term 2015 – second semester

- **Generation and Distribution of Energy**
- **Management I**
- **Research Skills**
- **Society and Economy**
- **Elective Bioenergy I**
- **Elective Wind Energy**
- **Internship**

Course			
M.Sc. Renewable Energy Management			
Availability to other courses **----**			**Instruction Language** English
Module No. **93110**	**Module name** **Energy and sustainable development**		**Semester/return** 1st Sem. / annual
Workload/presence 5 ECTS-P (150h/60h)	**Prerequisite module(s)** ---	**Follow-up module(s)** ---	**No. of participants** Max. 55
Teaching form Lectures, group work, excursion	**Examination form** Exam	**Start date** 20.10.2014	**Location** t.b.a.

Module coordinator: Prof. Dr. Uwe Eduard Schmidt (uwe.e.schmidt@ifp.uni-freiburg.de)

Additional teaching staff

Dr. Roderich von Detten, Prof. Dr. Jürgen Huss, Philip Thapa, Prof.Dr.Dr. Ernst Ulrich von Weizsäcker

Syllabus

With the help of historical analysis the students are to learn about the history of perception, and the awareness and conservation of nature. How the scarcity of natural resources affected life will be exemplified by having a closer look at different periods of time. Solutions provided by evolution, early ideas to use regenerative energies, historical efforts to implement sustainable management systems and strategies to solve the energy problems of the past will be put to the test. The major failures of ancient societies like mismanagement of resources, and the need of sustainable development will be pointed out in the case study of European forest management in history. Students will learn about the principles of sustainable development and the interdependencies of ecological, economical and social/political aspects of natural resource management. The historical case studies will serve to reveal the link between the use of resources in the past and its affects on our lives at present.

One focus for sustainable development will be the fight against climate change. Aside from renewable energies, the most powerful strategy in this regard is a massive increase of energy productivity. Similarly, a sustainable strategy of dealing with increasing non-energy resource scarcity (water, metals, phosphorus etc.) is a massive increase of resource productivity. Examples of big productivity gains will be shown from a wide range of industrial sectors, transport, buildings, and agriculture. Also, policy options will be discussed to steer technologies and investments in the right direction. One strategy, in particular deserves consideration: a gradual and steady increase of prices of the use of energy and the extraction of mineral resources. Finally, also the question of sufficiency and happiness with less turnover (e.g. the “Bhutan model”) will be discussed.

A further focus of the module deals with the ethical aspects of sustainability: the students will develop awareness of the ethical aspects of sustainability and gain basic knowledge on different ethical theories and their possible contribution to the justification of sustainability. An introduction into environmental ethics and the controversy between weak and strong sustainability is followed by an analysis of different implementation strategies of sustainability, including the question of a “sustainable lifestyle”.

The module is designed in an interactive manner and encourages strong student participation. Lectures, offering a detailed introduction, are accompanied by different didactical methods, such as autonomous group work with short presentations, panel discussions etc. On the basis of the acquired knowledge, student groups (5-6) conduct case studies on different topics concerning the ethical and historical aspects of sustainability and climate change. The results will be presented in a self-organized manner.

Learning goals and qualifications

- Knowledge about perception, awareness and conversation of nature in history
- Scarcity of natural resources and historical concepts of sustainable development including its ecological, economical and social dimension
- Resource productivity and new political frameworks as central aspects of sustainable development
- Awareness of the ethical aspects of sustainable development, especially the problem of climate change
- Basic knowledge of the main ethical theories and ethical argumentation skills
- Additional general skills: rhetoric, discussion and presentation skills, capacity for team work

Recommended reading

Saarinen, Thomas F.: ***Environmental perception and behaviour: an inventory and prospect*** / Thomas F. Saarinen , eds.. - Chicago, Ill.: Univ. of Chicago, Dep. of Geography, 1984. - X, 263 p.;

Simmons, Ian G.:***Global environmental history: 10,000 BC to AD 2000/I***. G. Simmons.-Edinburgh: Edinburgh Univ. Press, 2008. – XVI, 271 p. (eng)

Von Weizsäcker, E., Hargroves K., Smith M.H., Desha C.: ***"Factor Five"*** (Earthscan, London, 2009)

Ott, Konrad: ***Essential components of Future Ethics***. In: Döring, Ralph / Rühs, Michael (eds.): Ökonomische Rationalität und praktische Vernunft. P. 83-108.

Course prerequisites

None.

<table>
<tr><td colspan="4">Course
M.Sc. Renewable Energy Management</td></tr>
<tr><td colspan="3">Availability to other courses
---</td><td>Instruction Language
English</td></tr>
<tr><td>Module No.
93120</td><td colspan="2">Module name
Scientific Framework for REM</td><td>Semester/return
1st Sem. / annual</td></tr>
<tr><td>Workload/presence
10 ECTS (300h/100h)</td><td>Prerequisite module(s)
---</td><td>Follow-up module(s)
---</td><td>No. of participants
max. 55</td></tr>
<tr><td>Teaching form
Lectures, tutorials</td><td>Examination form
Written exam</td><td>Start date
20.10.2014</td><td>Location
t.b.a.</td></tr>
<tr><td colspan="4">Module coordinator: Prof. Dr. Stefan Baumgärtner, Prof. Dr. Leo Reindl</td></tr>
<tr><td colspan="4">Additional teaching staff:, Dr. Roderich von Detten, Dr. Oswald Prucker, Dr. Michael Henze, Dr. Adnan Yousaf</td></tr>
<tr><td colspan="4">Syllabus
This module is designed to harmonize the heterogeneous background knowledge due to the interdisciplinary and internationality nature of the M.Sc. REM course by providing fundamental knowledge about diverse subjects relevant for this course. At the beginning, the current knowledge in physics, chemistry, biology, engineering, politics, economics, business, and law will be tested and recommendations will be given to the student, which lectures with a total workload of 10 ECTS they should take to fill their knowledge gaps

1. Introduction in Physics, Chemistry, Biology and Engineering
In this module, the basics of mechanics, thermodynamics, electro statics and dynamics, as well as optics are discussed in a physics class. An overview over the chemistry (e.g. assembly of elements, chemical bindings, chemical reactions, organic molecules, polymers) and biology (e.g. photosynthesis, cells in a perspective of biomass) is given. An engineering class provides the students with the fundamental knowledge on electricity (e.g. basics of electronics, electric components, Kirchhoff's laws, diodes, three-phase current)

2.Introduction into Politics, Economics, Business and Law
The course gives an overview on basic concepts of policy and economic sciences. This includes basics of the political system, multilevel governance, the policy process, the use of political and market instruments and the management of enterprises. Regulative instruments are in focus.
Basics of business economics: Classical & modern theories & approaches of Organization & Management, Context of Management (interactions between firms and the business environment), Strategic Aspects of Management; Organisation Structures and Processes; Decision Making in organizations</td></tr>
<tr><td colspan="4">Learning goals and qualifications
1. Introduction in Physics, Chemistry, Biology, and Engineering
The students acquire basic knowledge in physics and engineering to provide the required prerequisites for advanced technology classes. The students understand the concepts of thermodynamics, mechanics, electro statics and dynamics, and optics as well as the electric engineering, which consists of electrical components, electrical circuits and conduction. The students learn fundamental concepts of chemistry and biology providing a basis for understanding biomass and conversion into bioenergy. This includes the classifications and properties of basic elements of the periodic table and survey the different bonding mechanisms and resulting chemical species, the fundamentals of chemical reactions including stoichiometry with a specific emphasis on reactions relevant to biomass such as acid / base reactions.</td></tr>
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2.Introduction into Politics, Economics, Business and Law

Participants will have a basic knowledge of policy, economic and management theory. They understand the principles of the legal framework of land use as well as the role of organizations as bottlenecks for the implementation of sustainability strategies. Students understand the rational of social and economic sciences (methodology, methods). They are able to adopt theoretical concepts to practical questions and use them as a tool to understand the formulation and implementation of energy policy.

Recommended reading

Tipler, Mosca: Physics for Scientists and Engineers; Freeman, 6th edition, 2007 (Part I, II, III, IV, V)
Boylestad, Nashelsky, Electronic Devices and Circuit Theory, Prentice Hall, 7th edition
Orrrest M. Mims, Getting Started in Electronics, 12th edition (1994) – *soft copy for the students will be provided*.
Economy & Management: Selected chapters from : Cole, G. a. 2003. Management. Theory and Practice. 6th edition. Cengage Learning (UK) & Parkin, M., Powell, M. and Matthews, K. 2003 Economics, 5th Edition, Harlow: Addison-Wesley; during the module materials will be made available via the learning platform ILIAS

Course prerequisites

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<table>
<tr><td colspan="4">Course
M.Sc. Renewable Energy Management</td></tr>
<tr><td colspan="3">Availability to other courses
---</td><td>Instruction Language
English</td></tr>
<tr><td>Module No.
93130</td><td colspan="2">Module name
Natural Resources and Conversion Technologies</td><td>Semester/return
1st Sem. / annual</td></tr>
<tr><td>Workload/presence
10 ECTS (300 h/100 h)</td><td>Prerequisite module(s)
Scientific Framework for REM</td><td>Follow-up module(s)
Generation and Distribution of Energy</td><td>No. of participants
Max. 55</td></tr>
<tr><td>Teaching form
Lectures, Exercises, Seminar, lab experiments</td><td>Examination form
Written exam</td><td>Start date
07.01.2015</td><td>Location
t.b.a.</td></tr>
<tr><td colspan="4">Module coordinator: N.N.</td></tr>
<tr><td colspan="4">Additional teaching staff
PD Dr. Dirk Schindler (solar radiation & wind), Dr. Werner Platzer (solar thermal, solar power), Dr. Ralf Preu (photovoltaics), Stefan Baehr (wind energy), Prof. Dr. Markus Weiler (water & hydropower), Wenzel (geothermics & geothermal energy), Prof. Dr. Dirk Jäger (biomass & bioenergy)</td></tr>
<tr><td colspan="4">Syllabus
This module gives the students an overview and the fundamental knowledge of different renewable energy sources and their potentials as well as basics of the underlying conversion technologies.

1. Solar Radiation, Photovoltaics & Solar heat (2 weeks)
Solar radiation: Meteorological aspects of the utilization of solar radiation as a renewable energy source: processes, phenomena, solar radiation spectrum, spatial and temporal patterns of radiative fluxes in the atmosphere and at the earth’s surface. Calculation of solar irradiation on inclined collectors; methods for determining diffuse and direct solar radiation
Photovoltaics: Basics of solar cell principles and characterisation silicon photovoltaics value chain with focus on cell technology, overview over other photovoltaic technologies, simple design of photovoltaic systems, and calculation of energy gain.
Solar Thermal Energy: Basics of solar thermal energy conversion are given, which includes: flat plate and vacuum tube solar collector design, black and selective absorbers, basics of optical gains and calculation of conductive, radiative and convective heat transfer in solar collectors and piping, solar thermal system concepts for solar domestic hot water and solar assisted heating, hot water storage types. System concepts are addressed, such as forced circulation and natural circulations systems, with low and high flow. Overview on solar concentrating collectors is given. High temperature applications are addressed, such as solar process heat and concentrated solar thermal power (CSP). Eventually, simple economics and system comparison with conventional alternatives are discussed.

2. Wind & Wind Energy (1 week)
Meteorological aspects of the utilization of wind as a renewable energy source are discussed, such as processes, phenomena, spatial and temporal patterns of kinetic energy and airflow in the atmospheric boundary layer.
Furthermore, this part of the module gives an applied overview about wind technology, focusing on performance and feasibility. Main topics are: the evolution of the wind turbine (capacity, components) and the role of electric grids. Additionally, key factors of wind-project development will be analysed: construction pre-requisites, steps, methods and costs. Wind technology perspectives around the world will be part of the module as well.</td></tr>
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3. Water & Hydropower (1 week)

This part of the module gives a broad overview about the large number of different technologies and applications for producing hydropower and hydroelectricity. The state of hydropower worldwide and in certain countries will be addressed and calculations for hydropower and hydroelectricity output will be done. Further topics are: hydropower and environment, river ecology scientific discussion on dams (Internet: Hydro Association), aspects of hydropower economics, sustainable management of hydropower and case studies around the world. Hydropower as subject in the German EEG will be introduced as a model.

4. Geothermics & Geothermal Energy (1 week)

The potential of geothermal energy conversion is addressed, particularly of geothermal energy resources (Bucher): earth's thermal regime, energy budget of the earth, heat storage, heat transport, hot water in the heat reservoirs, hydraulic properties of fractured hard rock, geothermal potentials (distribution and assessment), geothermal energy resources

5. Biomass & Bioenergy (1 week)

This part of the module aims to provide general knowledge about standard biomass conversion technologies. Therefore basics in biomass chemistry and biomass composition will be given. Based on this, the three fundamental technologies of biomass conversion processes will be introduced to the students.

- thermo-chemical processing
- physical-chemical processing
- bio-chemical processing

The different biomass conversion technologies require a more or less specific kind of biomass. The students will learn about the requirements on biomass with respect to the conversion technologies. Advantages and disadvantages of each technology will be highlighted and suitability of each technology to produce power, heat or fuel will be discussed. To evaluate and to compare the different conversion processes, mainly aspects of energy efficiency and carbon balance are questioned and analysed based on a process oriented approach (LCA)

Learning goals and qualifications

The diversity of renewable energy harvesting is mediated to the students. They understand the potentials with respect to the spatial availability, the general technologies, the sustainability of renewable energy conversion at given conditions, challenges and risks, as well as solution strategies of many different kinds of renewable energy sources. The students learned the basic concepts of the different conversion technologies and know how the different renewable energy sources can be utilized in order to produce electric power, heat and/or fuel.

1. Solar Radiation, Photovoltaics & Solar heat (2 weeks)

Solar radiation: Comprehension of radiative processes in the atmosphere and at the Earth surface, application of knowledge about solar radiation at the earth's surface within the context of site assessment, analysis of methods used to quantify solar radiation incident at the earth's surface.

Photovoltaics: The students will understand the working principles of photovoltaics. They will understand the basic mechanisms of the generation of carriers by photon absorption. The focus will be on standard semi-conductor based photovoltaics. They will learn how a solar cell can be described by its characteristic current-voltage-dependence. They will learn about the different optical and electrical loss mechanisms, which limit the maximum efficiency of a photovoltaic device. They will gain a rough overview on the different technologies how to manufacture photovoltaic modules as well as the most important characterization methods. Finally they will get insight into cost issues and scenarios for the different technologies.

Solar Heat: The students will understand the working principles of solar collector systems and the main factors of the solar energy utilization. They will learn to estimate approximately the solar gains of solar thermal systems. The main factors influencing the output of system can be judged qualitatively. Within exercises optical solar gains and heat losses as part of the overall energy balance of a collector will be calculated. Based on that quantitative simple estimations of collector performance will be practised. They will understand the main features and the basic differences between concentrating and non-concentrating systems.

2. Wind & Wind Energy (1 week)

Comprehension of airflow patterns in the atmospheric boundary layer, application of knowledge about near-surface airflow within the context of site assessment, analysis of methods used to quantify the wind resource near the ground
The students will be able to understand the role of wind energy from the management perspective and to deduce future scenarios for this technology according to the natural conditions and legal framework of each country/region.

3. Water & Hydropower (1 week)

The students will get general and specific knowledge about principles, technologies, applications, problems and solutions regarding hydropower, ranging from micro to large systems, and the use of hydropower optimized towards sustainability. The students will be able to calculate the output and economics of hydropower. They will be able to compare, evaluate and manage different aspects of hydropower with the goal of sustainability.

4. Geothermics & Geothermal Energy (1 week)

The students acquire basic knowledge about the physics of the earth, the principles concepts of using geothermal energy, the technologies, the applications, the challenges as well as the solution strategies for geothermal energy conversion. They know how to evaluate potential of geothermal energy conversion at given local conditions with respect to sustainability and economics.

5. Biomass & Bioenergy (1 week)

Within this part of the module, the students will get an understanding on the principals of biomass conversion processes and the related requirements on biomass. Based on presented advantages and disadvantages of different conversion technologies, the students will be able to compare and evaluate these technologies. This basic knowledge on the conversion techniques will enable them to evaluate the different technologies with regard to production of power, heat or fuel. Furthermore competences in evaluation methods will be learned.

Recommended reading

- Duffie-Beckman: Solar Engineering of Thermal Processes.
- Martin Green: Solar Cells: Operating Principles, Technology, and System Applications.
- Richardson, J.: Bioenergy from sustainable forestry : guiding principles and practice: Kluwer Academic, 2002. 344 p.
- Ostergard,H.: Bioenergy and emerging biomass conversion technologies. Short paper based on presentation at the AG2020 Expert Workshop in Denmark, 8th May 2007.
- I. Stober and K. Bucher, 2009: Geothermal Energy, Geothermal Exploration. Springer Verlag, Heidelberg.
- Additional relevant literature will be presented in the module
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Course prerequisites

Content of the module “Scientific Framework for REM”

Module No.	Module name		Semester/return
93140	**Climate and Energy Policy**		1st semester / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
5 ECTS-P (150h/60h)	--	---	Max. 55
Teaching form	**Examination form**	**Start date**	**Location**
Lectures + group work assignments	Written test + group work presentations	23.02.2015	t.b.a.

Module coordinators: Prof. Dr. Mario Ragwitz

Additional teaching staff: Dr. Till Pistorius, Dr. Sibylle Braungardt, Barbara Schlomann

Syllabus

The prevailing focus of the module is on the governance of climate and energy issues and corresponding policies at different levels (international, national, regional), as well as on their interrelation to other policy fields. After a short introduction to the basics of political science, students will be confronted with the wide range of climate and energy issues as well as the resulting conflicts and their role in the international efforts to mitigate climate change. Targets of climate and energy policy will be presented as well as the broad range of related instruments, policy processes, involved stakeholders and their interests.
In particular the module will cover the fundamentals of:

- international climate policy, including different concepts of effort sharing and the role of different countries / world regions in international negotiations of mitigation targets,
- energy policy, incl. instruments targeted at security of supply, energy efficiency, environmental sustainability,
- electricity markets and the impact of energy policy on these markets,
- renewable energy policy including basic economic characterization of renewable energies in energy modelling,
- the energy transition in Germany.

The module is designed in a very interactive manner and encourages strong participation of the students. After detailed introductions and presentations to the different topics they will be asked to elaborate issues and present the results in a self-organized manner (group work), i.e. by

- conducting country case studies,
- preparation of short presentations on case studies conducted.

Furthermore, various guest speakers and experts from different fields and institutions will be invited to provide expert views and insights on the respective topics.

Learning goals and qualifications

The main goal of this interdisciplinary module is to provide in-depth knowledge and insights into concepts of energy policy and the international climate regime; the focus of the module is on the connection to strongly related issues and processes, e.g., national and international climate, energy and land use policies. Different scientific disciplines are merged, with the objective to foster an understanding of complex multi-level political issues. This includes

- the presentation of different types of instruments and the role of the policy mix
- the role of different actors and institutional aspects
- different governance levels of energy and climate policy (local, regional, national, international)
- steps in the policy process (design, implementation, monitoring, evaluation, etc)
- role of scenarios (normative, explorative, projective), dealing with uncertainties
- cost aspects (system analytic, distributional effects, external costs)

Development of the following skills

- ability to analyze complex contextual knowledge
- interdisciplinary work
- ability to evaluate policy programmes and instruments
- rhetoric, discussion and presentation skills
- team work
- fostering of problem solving competences

Recommended reading

Metz, B. (2010): Controlling climate change. Cambridge university press. 350 p
http://www.iea.org/policiesandmeasures/climatechange/
http://www.worldenergyoutlook.org/
http://unfccc.int/resource/process/guideprocess-p.pdf
http://www.uneptie.org/energy/publications/pdfs/EmissionsTrading-Feb03.pdf
http://www.bmu.de/files/pdfs/allgemein/application/pdf/reccs_endbericht_kurz_en.pdf
http://www.grida.no/publications/rr/natural-fix/ebook.aspx
http://www.bmu.de/files/english/renewable_energy/downloads/application/pdf/broschuere_ee_zahlen_en.pdf

Course prerequisites

- Teaching context of module “Energy and sustainable development”
- Basic knowledge regarding environmental issues associated to climate change

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
6900	**Internship (Praktikum)**		2nd - 3rd Sem. / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
10 ECTS-P (300 h)	---	---	max. 30
Teaching form	**Examination form**	**Start date**	**Location**
Practical work	Written report	18.08.2014	t.b.a.

Module coordinators: Prof. Dr. Dr. h.c. Gero Becker

Additional teaching staff

Academic experts of the respective internship institution

Syllabus

The MSc. programmes at the Faculty of Environment and Natural Ressources Freiburg as a rule include a practical training in accordance with the examination regulations for the degree programme Master of Science (annex specific regulations § 4). The practical training is completed in institutions and companies outside the faculty or in research departments of the ZEE and his partners.
Possible internship providers include:

- Renewable energy and power supply companies
- Planning and Engineering companies
- Consultancy and information services (energy agencies, technology transfer institutions) and public relation
- Science and research dealing with renewable energies
- Financing and Investment companies specialising in financing environmental projects, as well as investment and development banks

Learning goals and qualifications

The internship should provide students with a first insight into potential employment sectors; in all sectors this is primarily achieved by practical work. Apart from gaining an overview of the subject, students should experience typical work processes and the human interactions in an organization. The assigned work should give students an idea of the daily work procedure at their workplace ('everyday life experiences'). Additionally, students should become familiar with the structures within the institution, as well as the interconnections with external systems.
Furthermore, the expert knowledge gained in the course of the studies should be intensified and to a certain degree, applied during the practical training.

Recommended reading

To be suggested individually by coordinator and internship institution

Course prerequisites

None.

Course M.Sc. Renewable Energy Management			
Availability to other courses ---			**Instruction Language** English
Module No. **93330**	**Module name** **Student Organized Event**		**Semester/return** 3rd semester/ annual
Workload/presence 5 ECTS-P (150 h/40 h)	**Prerequisite module(s)** ---	**Follow-up module(s)** ---	**No. of participants** Max. 30
Teaching form Workshop, Group work	**Examination form** Presentations in pitch rounds	**Start date** 10.11.2014	**Location** t.b.a.
Module coordinator: Prof. Dr. Dr. h.c. Gero Becker			
Additional teaching staff ---			

Syllabus

Students will select a current topic from the field of renewable energy management in the first year of their studies and develop it further so that they will be able to conceptualise and organise a scientific event in their third semester, e.g. an international workshop, seminar or conference, under the supervision of teaching staff but under their own responsibility. The professors only provide administrative and conceptual support. The process of preparing of the event will be accompanied by short training courses in 'project management'.
The aim of each sitting of the Freiburg Forum on Renewable Energy Management is to deal with a current, internationally relevant renewable energy issues. The purpose is to process in depth theoretical knowledge for presentation to a wider public and to foster discussion.
In addition to the interested members of the general public, the Freiburg Forum on Renewable Energy Management targets specifically economic, political and societal decision-makers. The forum is organised as an international meeting for participants from around the world.

Learning goals and qualifications

In this module students are expected:

- to review and to structure discussions on renewable energy issues
- to conceptualize and organise an international scientific event
- to understand the role of renewable energy management

Development of the following qualifications is supported:

- Project management skills
- Consultancy qualifications (presentations in short time, pitch rounds)
- Organisation skills
- Teamwork

Recommended reading

To be delivered individually at the start of the module.

Course prerequisites

None.

<table>
<tr><td colspan="4">Course
M.Sc. Renewable Energy Management</td></tr>
<tr><td colspan="3">Availability to other courses
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English</td></tr>
<tr><td>Module No.
93310</td><td colspan="2">Module name
Management II</td><td>Semester/return
3rd Sem. / annual</td></tr>
<tr><td>Workload/presence
5 ECTS-P (150h/60 h)</td><td>Prerequisite module(s)
Management I, Societal framework for REM</td><td>Follow-up module(s)
---</td><td>No. of participants
max. 30</td></tr>
<tr><td>Teaching form
Lectures, Exercises, Case studies, Seminar</td><td>Examination form
Seminar presentation, written exam</td><td>Start date
01.12.2014</td><td>Location
t.b.a.</td></tr>
<tr><td colspan="4">Module coordinator: Prof. Dr. Marc Hanewinkel</td></tr>
<tr><td colspan="4">Additional teaching staff: Dr. Roderich von Detten (r.v.detten@ife.uni-freiburg.de)</td></tr>
<tr><td colspan="4">Syllabus
1. Management Theory
Classical Theory, Bureaucracy, Human Relations and Social Psychological Theories, Systems and Contingency Approaches, new approaches
2. Management cycle
Planning and Control, Organisation, Personnel Management, Controlling
3. Functional Management
Marketing, Production, Investment and Finance, Logistics
4. Case Studies: Management System of real world companies</td></tr>
<tr><td colspan="4">Learning goals and qualifications
➢ Learning about management of firms (describe, understand, apply)
➢ Being able to apply the acquired knowledge in practice
➢ Being able to analyse and to create concepts for different problems and situations from an entrepreneurial perspective
➢ Additional general skills: rhetoric, discussion and presentation skills, capacity for team work</td></tr>
<tr><td colspan="4">Recommended reading
There are several excellent introductions to business administration and management. Standard literature will be introduced during Management I.</td></tr>
<tr><td colspan="4">Course prerequisites
Teaching content of module „Management I“ and “Societal Framework for REM”.</td></tr>
</table>

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
93150	**Integrated Case Study**		3rd Sem. / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
5 ECTS-P (150h/60 h)	Management I, Societal framework for REM	---	max. 30
Teaching form	**Examination form**	**Start date**	**Location**
Lectures, Exercises, Integrated Case studies, Group work	Presentation, Report	07.01.2015	t.b.a.

Module coordinator: Prof. Dr. Dr. h.c. Gero Becker

Additional teaching staff: Dr. Ramchandra Bhandari, Dr.-Ing. Doreen Kalz, Dr. Chantal Ruppert-Winkel

Syllabus

The module focuses on the principles of experiential learning, whereby students actively participate in a practical oriented research topic. The contents continually build upon previously acquired skills and the set-up allows students to link theory to real-world experience.

Students will choose one topic from a specific research area (e.g. energy efficiency, geographical information system (GIS) for planning of renewable energy projects, rural electrification). A corresponding real world problem will be presented and introduced to the students. The task to solve the problem addressed as research question(s) is being performed by the students as group work (selection of setu-up and tools, data collection, calculations, critical discussion of results) with support of experts and lecturers.

Within the case study rural electrification, the students will have to plan a rural electrification project for a location of their choice. The choice of energy supply resources such as wind or solar or others or hybrid would be site specific. At the end of this module, a detailed project plan for that particular location has to be developed, which includes all the necessary details from technical, economic and social aspects. Students will be working in groups, each group containing 2-3 members. A final project report as well as a presentation in class will fulfil the examination requirements.

Learning goals and qualifications

Students will

- learn how to work scientifically with an real world example (“case study”)
- learn to integrate all aspects of the programme (“integrated case study”)
- learn to work in a team

Recommended reading

To be delivered individually at the start of the module

Course prerequisites

All previously taught core modules and Elective I.

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
93932	**Elective II - Bioenergy**		3rd Sem. / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
5 ECTS-P (150 / 60h)	Technology I,II	none	Max. 15
Teaching form	**Examination form**	**Start date**	**Location**
Lectures, excursions	Written Exam	26.01.2015	t.b.a.
Module coordinator: Prof. Dr. Dr. h.c. Gero Becker			
Additional teaching staff: N.N.			

Syllabus

The module focuses on the conversion of non-wood (agriculture) biomass as well as on their availability and suitability for different conversion technologies.

In a first step conversion technologies, which are mainly suitable for non-woody biomass, will be presented and discussed in detail. The chemical background and progress will be elaborated for the following conversion technologies:

- bio-gas from anaerobe digestion
- bio-oil from pressing and extraction
- bio-methanol from transesterfication
- bio-ethanol from alcoholic fermentation

Additionally new developments for fuel cell concepts based on bio-technology will be touched.

In a second step the question of biomass availability will be raisin. Therefore the cultivation and production technologies of energy crops (e.g. corn, miscanthus) in agriculture systems will be presented and discussed. Following this, the supply logistic chains, including harvesting and transportation will be presented on selected examples. Furthermore alternative organic resources (e.g. organic waste) will be in the focus of the lecture. In this context, concepts of an integrated organic waste management will be presented.

Excursion within the module will provide practical background information and give examples on some of these technologies.

A project work, reflecting and integrating the lecture content, will be part of the last week within the module. The project work will handle an actual topic, e.g. energy potential of different resources (organic waste vs. corn) for a certain region. Sustainability and energy efficiency will be compared for different conversion technologies / raw material options.

Learning goals and qualifications

The students will learn about the techniques of non-wood biomass conversion. They will be able to distinguish between the technologies by assessing the advantages and disadvantages.

Furthermore the students will learn about biomass on agricultural land systems. Techniques of cultivation, harvesting and logistics will be explained, so the students will be able to design a sustainable concept of using non-wood biomass.

The students will be able to make a critical analysis of profitability, efficiency and sustainability, reflecting biomass production and alternative purposes, including environmental side-effects.

The students will learn how to summarize essential information and to present them in written and oral form.

Recommended reading:

- Biomass and Agriculture , Sustainability, Markets and Policies (2004). 568 pp. ISBN: 9789264105546; OECD Code: 512004011E1.
- Guidelines for Life-Cycle Assessment: A "Code of Practice„ Consoli, F.; Allen, D.; Boustead, I.; Fava, J.; Franklin, W.; Jensen, A.; Oude, N.; Parrish, R.; Perriman, R.; Postlethwaite, D.; Quay, B.; Seguin, J.; Vigon, B. SETAC-Society of Environmental Toxicology and Chemistry, 1993.

Additional literature will be given within the module.

Course prerequisites

The students should bring the teaching contents of the modules “Technology I and II”.
Basic knowledge in statistics, economy and life cycle assessment are required.
The recommended reading gives a basic knowledge about the issues discussed in this part of the module.

<table>
<tr><td colspan="4">Course
M.Sc. Renewable Energy Management</td></tr>
<tr><td colspan="3">Availability to other courses
----</td><td>Instruction Language
English</td></tr>
<tr><td>Module No.
93902</td><td colspan="2">Module name
Elective II Energy Efficiency – Wind energy</td><td>Semester/return
3rd Sem. / annual</td></tr>
<tr><td>Workload/presence
5 ECTS-P (150h/60h)</td><td>Prerequisite module(s)
Elective I</td><td>Follow-up module(s)
---</td><td>No. of participants
Max. 15</td></tr>
<tr><td>Teaching form
Lectures, Excursion</td><td>Examination form
Written exam</td><td>Start date
26.01.2015</td><td>Location
t.b.a.</td></tr>
<tr><td colspan="4">Module coordinator: Prof. Dr. Mario Ragwitz</td></tr>
<tr><td colspan="4">Additional teaching staff
Dr. Claus-Peter Gross, Dr. Marian Klobasa, Daniel Kowalski</td></tr>
<tr><td colspan="4">Syllabus
The Wind Energy module will give the students a brief but thorough introduction to the science and technology of wind turbines and utilization of wind energy for power generation.
The module will be structured into the following components:
• Introduction and motivation: Development of wind energy in Europe and globally
• Consolidating basic knowledge of wind energy technology already provided in module “Technology II”
• Potential assessment and geo-modeling of sites including environmental aspects
• Economics of wind power and wind energy project development
• Integration of wind power into the electricity system
• Policy design for the future development of wind energy

The first component will present the past and present status of wind energy and its contribution to the overall energy mix, introduce recent economic and technical developments and challenges of wind energy, main drivers and barriers as well as future scenarios of wind energy development.

The second component will review the fundamentals of wind and wind harvesting incl. the stochastic nature of the wind and the statistic parameters, the aerodynamics of wind turbines and the technological characterisation of wind turbines / system components. This will include statistical tools used to describe the wind (Weibull, etc.), the physics of a wind turbine including the Betz limit, the aerodynamics of turbine blades and the mechanics of wind turbines and turbine types (power curve, capacity factor, stall vs. pitch wind turbines, direct drive vs. geared turbine).

The third component will cover the practical realisation and economics of wind power projects. From a project developers perspective the following aspects will be presented:
• Acquisition of a project, technical project management, wind park planning
• Due Diligence of the entire project
• Financial Issues/Business Models

The fourth component concentrates on the integration of wind energy in the energy system based on the challenges of fluctuating electricity generation It contains key approaches to facilitate system and grid integration of wind energy incl. network expansion requirements as well as strategies for increasing the flexibility of the power system.

The final component will present best practices of policy design for wind energy in the context of different energy economic framework conditions incl. approached for improved market introduction of wind energy.

If possible the Wind Energy Module will also include a field trip to a local wind turbine in Baden-Württemberg.

The lessons learned from the module components will be utilized by the students in the final project.</td></tr>
</table>

Learning goals and qualifications

- Knowledge on main drivers and barriers for wind energy development in the EU and globally
- Understanding of the stochastic nature of the wind and the statistic parameters used to summarize the wind.
- Introduction to the physics and mechanics of wind power and the physical limits.
- Basic understanding of the various turbine typologies and economic reasoning behind the types.
- Understanding the methodology of GIS based assessment of wind energy potentials
- Fundamental understanding of the issues involved with wind park planning, including the necessity to understand local conditions, including social/political/environmental issues.
- Knowledge on the practical realization of wind projects from a technical and economic perspective
- Basic understanding of approaches to system and market integration of wind energy
- Insights into the design of effective and economically efficient policies for wind energy
- Additional general skills: rhetoric, discussion and presentation skills, capacity for team work

Recommended reading (*available at www.ub.uni-freiburg.de)

Wind Energy – the Facts: Technology, Economics, grid integration, industry and markets and environmental issues of wind power **(http://www.wind-energy-the-facts.org/)**

Wind energy explained* : theory, design and application / J. F. Manwell and J. G. McGowan ; A. L. Rogers. - 2. ed.. - Chichester : Wiley, 2009

Wind turbines* : fundamentals, technologies, application, economics; Erich Hau. - 2. ed.. - Berlin ; Heidelberg [u.a.] : Springer, 2006

Wind Energy Handbook – Burton et al.

Wind Power Plants: Fundamentals, Design, Construction and Operation– Gasch, Twele

http://windpower.org/en/

Course prerequisites

None.

<table>
<tr><td colspan="4">Course
M.Sc. Renewable Energy Management</td></tr>
<tr><td colspan="3">Availability to other courses
---</td><td>Instruction Language
English</td></tr>
<tr><td>Module No.
93912</td><td colspan="2">Module name
Elective II
Photovoltaic & Solar Thermal Energy</td><td>Semester/return
3rd Sem. / annual</td></tr>
<tr><td>Workload/presence
5 ECTS-P (150/60h)</td><td>Prerequisite module(s)
Elective I Photovoltaic + solar thermal energy</td><td>Follow-up module(s)
---</td><td>No. of participants
Max. 15</td></tr>
<tr><td>Teaching form
Lectures, exercises, student presentations</td><td>Examination form
Written exam plus presentation or report</td><td>Start date
26.01.2015</td><td>Location
t.b.a.</td></tr>
<tr><td colspan="4">Module coordinators: Prof. Dr. Volker Wittwer (volker.wittwer@ise.fraunhofer.de, Dr. Werner Platzer (werner.platzer@ise.fraunhofer.de)</td></tr>
<tr><td colspan="4">Additional teaching staff: Dr. Peter Schossig, Dr. Andreas Georg</td></tr>
<tr><td colspan="4">Syllabus
In this module the students will learn about energy efficiency in relation to:
- Solar availability and demand profiles for domestic hot water, solar assisted heating, process heat and cooling
- Materials and coatings for glazings, absorbers (antireflex, low-emissivity, selectivity)
- Passive solar concepts and components (windows, transparent insulation)
- Solar thermal conversion using non-concentrated and concentrated collectors
- Hydraulics and design of collector fields (stagnation, flow-regimes, pressure drop, flow distribution)
- Thermal storage concepts
- Concentrated solar thermal power (CSP): Solar field concepts, system aspects
- Use of heat engines and thermodynamic cycles (Rankine, Organic Rankine etc.) in CSP
- Combining of CSP with process steam generation, heating, cooling and desalination</td></tr>
<tr><td colspan="4">Learning goals and qualifications
In this course, students will learn about energy efficiency and specifications with respect to a variety of solar thermal systems. They will learn temperature and efficiency limitations, how to improve thermal systems by specific material design and selection and by solar concentration. System analysis with respect to storage concepts, hydraulic flow regimes and flow control will be intensified. Solar thermal power generation using heat engines will be introduced and combinations with other process like absorption cooling or desalination be discussed. The students should be able to understand the interrelations between system components know different system concepts and approximately calculate the solar gains of different systems. The depth and detail of knowledge and understanding should go much beyond the level of Technology I and II.</td></tr>
<tr><td colspan="4">Recommended reading
Duffie-Beckman: Solar Engineering of Thermal Processes
Volker Quaschning, Understanding Renewable Energy, Earthscan, 2005
Siegel, Howell, Thermal Radiation Heat Transfer, 4th ed., Taylor and Francis, New York, 2001.</td></tr>
<tr><td colspan="4">Course prerequisites
Content of the module Elective I Photovoltaics and Solar Thermal Energy.</td></tr>
</table>

<table>
<tr><td colspan="4">Course
M.Sc. Renewable Energy Management</td></tr>
<tr><td colspan="3">Availability to other courses
---</td><td>Instruction Language
English</td></tr>
<tr><td>Module No.
93340</td><td colspan="2">Module name
Project</td><td>Semester/return
3rd Sem. / annual</td></tr>
<tr><td>Workload/presence
5 ECTS-P (150h/60h)</td><td>Prerequisite module(s)
Research Skills, Elective I</td><td>Follow-up module(s)
---</td><td>No. of participants
Max. 30</td></tr>
<tr><td>Teaching form
Seminar, self study, students presentation</td><td>Examination form
Written report</td><td>Start date
16.02.2015</td><td>Location
t.b.a.</td></tr>
<tr><td colspan="4">Module coordinator: Prof. Dr. Dr. h.c. Gero Becker</td></tr>
<tr><td colspan="4">Additional teaching staff: All lecturers of REM study programme</td></tr>
<tr><td colspan="4">Syllabus
• During REM study programme – especially the modules “internship”, “Elective I” and “Elective II” research related projects are being identified by the students and the associate professor.
• The goal of the module is that each student identifies the research topic of own interest. Using the knowledge acquired in the module “Research Skills”, each student should develop a research proposal that meets the standards for a master thesis proposal at ZEE.
• The proposal should describe at least the problem statement, research questions, literature review (state of the art), methodology, expected results, time and budget plan and a proposed table of content of the thesis.
Milestones:
• At the beginning: selection/identification of research topic
• Searching the supervisor (professor)
• At the end of the module: presentation of the proposal and project report</td></tr>
<tr><td colspan="4">Learning goals and qualifications
Students will
• get an introduction on how to work scientifically with an real world example
• deepen their knowledge in the specialisation chosen during Elective I and II (“Learning by doing”)
• learn to work in a team
• practice to manage a project</td></tr>
<tr><td colspan="4">Recommended reading
Information about recommended reading will be provided by supervising professor individually.</td></tr>
<tr><td colspan="4">Course prerequisites
Content of modules Research Skills and Elective I.</td></tr>
</table>

<table>
<tr><td colspan="4">Course
M.Sc. Renewable Energy Management</td></tr>
<tr><td colspan="3">Availability to other courses
---</td><td>Instruction Language
English</td></tr>
<tr><td>Module No.
93210</td><td colspan="2">Module name
Generation and Distribution of Energy</td><td>Semester/return
2nd Sem. / annual</td></tr>
<tr><td>Workload/presence
5 ECTS/(100h/50h)</td><td>Prerequisite module(s)
Natural Resources and Conversion Technologies</td><td>Follow-up module(s)
Elective modules</td><td>No. of participants
Max. 55</td></tr>
<tr><td>Teaching form
Lectures, excursions, seminar, lab experiments</td><td>Examination form
Exam</td><td>Start date
13.04.2015</td><td>Location
t.b.a</td></tr>
<tr><td colspan="4">Module coordinator: Prof. Dr. Leonard Reindl</td></tr>
<tr><td colspan="4">Additional teaching staff
Prof. Dr. Leonard Reindl, Dr. Claus-Peter Gross</td></tr>
<tr><td colspan="4">Syllabus
To understand the role of renewable energies for sustainable energy systems, it is essential to know how our today's electricity system actually works. In this module, today's energy systems are discussed from the energy production via the distribution of the electricity to the socket of the end user. This includes the technological view of energy production by classical power plants; transformation of energy and the different voltage levels, as well as the stabilisation of and the distribution by the electricity grid.
The distribution of renewable energy sources is discussed and the geographic information systems introduced. Geographical presentation and analyses of electricity networks in Geographical Information Systems (GIS) helps to understand current distribution grids and optimize planning for future demands. Basics in data formats, data bases, creation of data and modelling will be taught.</td></tr>
<tr><td colspan="4">Learning goals and qualifications
The students acquired fundamental knowledge of today's electricity systems, which is essential to integrate renewable energy power supplies effectively in existing electricity systems in terms of technology, economics and sustainability. The students understand how electricity is distributed by the electricity grid and know what can be done to solve challenges in the system stability and the security of supply.
The students get hands on information on managing, analyses and presentation of data in electricity networks.</td></tr>
<tr><td colspan="4">Recommended reading
• Relevant literature will be given to the student in advance and also presented in the module</td></tr>
<tr><td colspan="4">Course prerequisites
Content of the module "Scientific Framework for REM" and "Natural Resources and Conversion Technologies".</td></tr>
</table>

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
93220	**Management I**		2nd Sem. / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
5 ECTS-P (150h/60 h)	--	Management II	max. 30
Teaching form	**Examination form**	**Start date**	**Location**
Lectures, Exercises, Seminar	Seminar presentation, written exam	19.05.2014	t.b.a.

Module coordinator: Prof. Dr. Marc Hanewinkel

Additional teaching staff: Dr. Roderich von Detten (r.v.detten@ife.uni-freiburg.de)

Syllabus

1. Basics of economics
   - 1.1 Fundamental terms of economic activity
     (Allocation, distribution, division of labour, exchange, micro- and macroeconomic flow of goods and money).
   - 1.2 Typology of economic units
     (Households - firms - organisations in the so-called tertiary sector)
   - 1.3 Typology of economic systems
     - overview
     - focus: social and ecological committed market economy
     - normative underpinnings: efficiency, ecological sustainability, justice
     - coordination mechanisms: state - market – civil society
   - 1.4 About the interplay of the political and the economic system
2. Basics of management
   - 2.1 Overview: What is management about?
   - 2.2 Economical dimension – added value in firms (Business Simulation “Factory”)
   - 2.3 Social dimension – the firm is an organisation
   - 2.4 Ecological consequences of commercial action
   - 2.5 Goals and decisions in the focus of entrepreneurial action
   - 2.6 Management cycle – planning, organisation, human resources, accounting, controlling
3. Project management
4. Strategical Management

Learning goals and qualifications

- Knowledge of fundamental economic concepts as a basis for the application of business instruments
- Ability to apply strategic management concepts
- Additional general skills: rhetoric, discussion and presentation skills, competence for team work

Recommended reading

There are several introductions to economy:

- e.g. for management: Cole, G. a. 2003. Management. Theory and Practice. 6th edition. Cengage Learning (UK).
- e.g. for economics: Parkin, M., Powell, M. and Matthews, K. 2003 Economics, 5th Edition, Harlow: Addison-Wesley

During the module materials will be made available via the learning platform ILIAS

Course prerequisites

None.

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
93320	**Research Skills**		1st Sem. / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
5 ECTS-P (150h/60 h)	--	---	max. 30
Teaching form	**Examination form**	**Start date**	**Location**
Lecture/ group work	Poster presentation and paper submission	01.06.2015	t.b.a.

Module coordinator: Prof. Dr. Stefan Baumgärtner

Additional teaching staff

Martina Attinger, Prof. Dr. Jürgen Bauhus, Dr. Simone Ciuti, Prof. Dr. Jürgen Huss,, Dr. Cornelia Korff

Syllabus

This module deals with the introduction of sciences and scientific methodology. There are no prerequisites required for this course.

In the first part of the module, students will be familiarized with the process of research including research strategy and cycle, literature review but also scientific misconducts and fraud. Students will get familiar with scientific citation and bibliography.

In the second part of the module, students will learn the main goals and methods of qualitative and quantitative research process. This part includes details about research design, data collection and data analysis.

At the end of the module, students will be prepared for scientific communication and scientific publications, such as writing papers, presenting posters, etc.

Learning goals and qualifications

- Students will be able to understand the main goals and common methods of qualitative and quantitative research (including empirical methods and statistics)
- Students will be able to develop meaningful research questions (hypothesis) and to design studies to evaluate their hypothesis (including research design, data collection and analysis)
- Students will be able to communicate their research results among scientific community via publications

Recommended reading

Curd, M. and Cover, J. A (1998): Philosophy of science - the central issue. W. W. Norton & Company, New York

McCaskill, M. K. (1998): Grammar, punctuation and capitalization: A handbook for technical writers and editors (NASA SP-7084). Langley Research Centre, Hampton, Virginia

Popper, Karl (2004): The logic of scientific discovery. London: Routledge-Classic

Strauss, A. and Corbin, J. (1990): Basics of qualitative research: Grounded theory procedures and techniques. Sage Publications

Others: to be announced in class

Course prerequisites

None.

<table>
<tr><td colspan="4">Course
M.Sc. Renewable Energy Management</td></tr>
<tr><td colspan="3">Availability to other courses
---</td><td>Instruction Language
English</td></tr>
<tr><td>Module No.
93230</td><td colspan="2">Module name
Society & Economy</td><td>Semester/return
2nd Sem. / annual</td></tr>
<tr><td>Workload/presence
10 ECTS-P (300/120h)</td><td>Prerequisite module(s)
Management I,
Climate & energy policy</td><td>Follow-up module(s)
Management II</td><td>No. of participants
max. 30</td></tr>
<tr><td>Teaching form
Lectures, Exercises, Excursions, Seminar</td><td>Examination form
Excursion Reports, Seminar presentation, Written Exam</td><td>Start date
22.06.2015</td><td>Location
t.b.a</td></tr>
<tr><td colspan="4">Module coordinator: Prof. Dr. Stefan Baumgärtner</td></tr>
<tr><td colspan="4">Additional teaching staff: N.N.</td></tr>
<tr><td colspan="4">Syllabus
• Introduction to the economics of renewable energy management
➢ Energy Markets: Competitive vs. Oligopolistic Markets
➢ Environmental Economics: Externalities, Governmental Policies, and the Case of Global CO_2 Emissions
• The socio-cultural setting – consumer behaviour
• Levels of legal regulation – energy law, contract law
• Interdisciplinary conditions of societal development:
➢ Society and responsible handling of environmental protection
➢ Society and technological progress – innovations, diffusion, risk assessment of technologies, handling of environmental risks
➢ Society and corporate social responsibility (CSR)
➢ International political framework and conflict management
➢ Economical behaviour in the so called tertiary sector.
➢ Governance of modern societies</td></tr>
<tr><td colspan="4">Learning goals and qualifications
Related to energy efficiency and renewable energy technologies:
• Understanding the working and failures of markets, especially with respect to energy provision and environmental effects
• Understanding the relations and interdependencies between different societal sectors
• Understanding the responsibilities and options
• Understanding the role and effects of company’s behaviour on the society</td></tr>
<tr><td colspan="4">Recommended reading
Different material will be provided on the learning platform ILIAS</td></tr>
<tr><td colspan="4">Course prerequisites
Content of the modules “Management I” and “Climate and Energy Policy”.</td></tr>
</table>

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
93931	**Elective Bioenergy I**		2nd Sem. / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
5 ECTS-P (150 / 60h)	Scientific Framework for REM, Natural Resources and Conversion	Elective II	Max. 25
Teaching form	**Examination form**	**Start date**	**Location**
Lectures, excursions	Written Exam	13.07.2015	t.b.a.
Module coordinator: Prof. Dr. Dirk Jäger			
Additional teaching staff			

Syllabus

The module will introduce into the most relevant energy conversion technologies related to wood biomass. Furthermore the important aspects of raw material procurement (production, harvesting, logistic) will be explained. Cross-dependency to alternative uses of wood (industrial processing) will be distinguished. It starts with detailed presentation of the principal conversion processes

- pyrolysis
- technical gasification
- combustion

Specifications of these processes are going to lead to different kind of energy products (solid, liquid or gas). These primary energies may be used direct or further processed into added value energy products. Within the lecture the production of synthetic fuels (BtL) and High Temperature Carbonisation (HTC) will be presented. Advantages and disadvantages of these processes will be discussed in terms of technology, products, energy efficiency and biomass resources. Lectures will also give attention to the production and characteristics of pellets.

To understand and evaluate the material base for the wood based bioenergy processes, biomass potentials from forests, saw mill residues and short rotation coppice (SRC) will be assessed. Also production potentials of biomass forest plantations will be part of the lecture. The topic of harvesting and supply concepts will be touched as well.

Excursion within the module will give practical background information and present examples of these technologies.

A case study, which deals with actual topics -- e.g. economic and energy efficient production of pellets from SRC; energy concepts for an integrated energy supply -- will be part of the third week of the module.

Learning goals and qualifications

The students will achieve basic knowledge about conversion processes and technologies of woody biomass. They will be able to assess different technologies by knowing the advantages and disadvantages.

Furthermore the students will learn to assess the potentials of woody biomass supply and the production of intermediate products like wood chips and pellets. Based on the knowledge from the production side, the supply systems and knowing the principals of the conversion processes, the students will be able to analyse, evaluate and develop suitable, regional and sustainable wood energy concepts. They will be able to understand competition and integration between energy products (heat, power, fuel) and industrial wood based materials from the economic and ecologic point of view.

The students will learn how to summarize essential information and to present them in written and oral form.

Recommended reading

- Richardson, J.. Bioenergy from sustainable forestry: guiding principles and practice: Kluwer Academic, 2002. 344 S.
- Brenes, MD. Biomass And Bioenergy: New Research (2006): Chapter 2. Nova Science Pub Inc.
- Klugman,S.; Karlsson,M. and Moshfegh,K. (2007): A Scandinavian chemical wood-pulp mill. Part 2. International and model mills comparison. Applied Energy, Volume 84, Issue 3, Pages 340-350.

Additional literature will be given within the module.

Course prerequisites

The students should have joined the modules “Natural Resources”, “Technology of renewable energy Management” and “Societal Framework”.
The students should have basic knowledge in plant genetics to understand the mechanisms of genetic improvement of trees used in short rotation plantation for bio-energy. Also basic knowledge in biotic and abiotic risk management in forests and forest plantations is required.
For understanding the part of terrestrial and remote sensing inventory of semi-natural and planted forests as well as production modelling basic knowledge in descriptive and applied statistics are required.
For the case study the basic principles of energy cycles of wood processing industries are required. The readings recommended give a basic overview about the required knowledge in the module.

Course M.Sc. Renewable Energy Management			
Availability to other courses ----			**Instruction Language** English
Module No. **93902**	**Module name** **Elective Wind energy**		**Semester/return** 3rd Sem. / annual
Workload/presence 5 ECTS-P (150h/60h)	**Prerequisite module(s)** Elective I	**Follow-up module(s)** ---	**No. of participants** Max. 15
Teaching form Lectures, Excursion	**Examination form** Written exam	**Start date** 26.01.2015	**Location** t.b.a.
Module coordinator: Prof. Dr. Mario Ragwitz			
Additional teaching staff Dr. Claus-Peter Gross, Dr. Marian Klobasa, Daniel Kowalski			

Syllabus

The Wind Energy module will give the students a brief but thorough introduction to the science and technology of wind turbines and utilization of wind energy for power generation.
The module will be structured into the following components:

- Introduction and motivation: Development of wind energy in Europe and globally
- Consolidating basic knowledge of wind energy technology already provided in module “Technology II”
- Potential assessment and geo-modeling of sites including environmental aspects
- Economics of wind power and wind energy project development
- Integration of wind power into the electricity system
- Policy design for the future development of wind energy

The first component will present the past and present status of wind energy and its contribution to the overall energy mix, introduce recent economic and technical developments and challenges of wind energy, main drivers and barriers as well as future scenarios of wind energy development.

The second component will review the fundamentals of wind and wind harvesting incl. the stochastic nature of the wind and the statistic parameters, the aerodynamics of wind turbines and the technological characterisation of wind turbines / system components. This will include statistical tools used to describe the wind (Weibull, etc.), the physics of a wind turbine including the Betz limit, the aerodynamics of turbine blades and the mechanics of wind turbines and turbine types (power curve, capacity factor, stall vs. pitch wind turbines, direct drive vs. geared turbine).

The third component will start with an introduction to geographical information systems (GIS) to allow the presentation of techniques of geo-modelling of wind sites and GIS-based assessment of wind potentials. This will include the consideration of environmental constraints of wind park planning.

The fourth component will cover the practical realisation and economics of wind power projects. From a project developers perspective the following aspects will be presented:

- Acquisition of a project, technical project management, wind park planning
- Due Diligence of the entire project
- Financial Issues/Business Models

The fifth component concentrates on the integration of wind energy in the energy system based on the challenges of fluctuating electricity generation It contains key approaches to facilitate system and grid integration of wind energy incl. network expansion requirements as well as strategies for increasing the flexibility of the power system.

The final component will present best practices of policy design for wind energy in the context of different energy economic framework conditions incl. approached for improved market introduction of wind energy.

If possible the Wind Energy Module will also include a field trip to a local wind turbine in Baden-Württemberg.

The lessons learned from the module components will be utilized by the students in the final project.

Learning goals and qualifications

- Knowledge on main drivers and barriers for wind energy development in the EU and globally
- Understanding of the stochastic nature of the wind and the statistic parameters used to summarize the wind.
- Introduction to the physics and mechanics of wind power and the physical limits.
- Basic understanding of the various turbine typologies and economic reasoning behind the types.
- Understanding the methodology of GIS based assessment of wind energy potentials
- Fundamental understanding of the issues involved with wind park planning, including the necessity to understand local conditions, including social/political/environmental issues.
- Knowledge on the practical realization of wind projects from a technical and economic perspective
- Basic understanding of approaches to system and market integration of wind energy
- Insights into the design of effective and economically efficient policies for wind energy
- Additional general skills: rhetoric, discussion and presentation skills, capacity for team work

Recommended reading (*available at www.ub.uni-freiburg.de)

Wind Energy – the Facts: Technology, Economics, grid integration, industry and markets and environmental issues of wind power **(http://www.wind-energy-the-facts.org/)**

Wind energy explained* : theory, design and application / J. F. Manwell and J. G. McGowan ; A. L. Rogers. - 2. ed.. - Chichester : Wiley, 2009

Wind turbines* : fundamentals, technologies, application, economics; Erich Hau. - 2. ed.. - Berlin ; Heidelberg [u.a.] : Springer, 2006

Wind Energy Handbook – Burton et al.

Wind Power Plants: Fundamentals, Design, Construction and Operation– Gasch, Twele

http://windpower.org/en/

Course prerequisites

None.

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
6900	**Internship (Praktikum)**		2nd - 3rd Sem. / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
10 ECTS-P (300 h)	---	---	max. 30
Teaching form	**Examination form**	**Start date**	**Location**
Practical work	Written report	03.08.2015	t.b.a.
Module coordinators: N.N.			
Additional teaching staff			
Academic experts of the respective internship institution			

Syllabus

The MSc. programmes at the Faculty of Forest and Environmental Sciences Freiburg as a rule include a practical training in accordance with the examination regulations for the degree programme Master of Science (annex specific regulations § 4). The practical training is completed in institutions and companies outside the faculty or in research departments of the ZEE and his partners.

Possible internship providers include:

- Renewable energy and power supply companies
- Planning and Engineering companies
- Consultancy and information services (energy agencies, technology transfer institutions) and public relation
- Science and research dealing with renewable energies
- Financing and Investment companies specialising in financing environmental projects, as well as investment and development banks

Learning goals and qualifications

The internship should provide students with a first insight into potential employment sectors; in all sectors this is primarily achieved by practical work. Apart from gaining an overview of the subject, students should experience typical work processes and the human interactions in an organization. The assigned work should give students an idea of the daily work procedure at their workplace ('everyday life experiences'). Additionally, students should become familiar with the structures within the institution, as well as the interconnections with external systems.

Furthermore, the expert knowledge gained in the course of the studies should be intensified and to a certain degree, applied during the practical training.

Recommended reading

To be suggested individually by coordinator and internship institution

Course prerequisites

None.