ZEE Zentrum für Erneuerbare Energien

Module handbook

REM M.Sc. Renewable Energy Management

Academic year 2010/2011

State of 24.11.2010

Table of contents

Module handbook
Master of Science Renewable Energy Management

1. Introductory comments

According to § 14 of the examination regulation of the MSc Renewable Energy 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 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 Management(www.rem.uni-freiburg.de). Thus students have access to the module handbook before and during their studies. Furthermore the admission regulation, the examination regulation and the internship regulation are available via the REM website.

2. Schedule

2.1. Winter term

	Winter term 2010/2011 - First Semester																									
	October			November						December				January				February				March					
CW				42	43	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11	12	CW
	14.-15.10.			18.10 – 05.11.			08.11. - 26.11.			29.11. – 17.12.			- 2.01.		03.01–21.01			24.01. – 11.02.			14.02. - 04.03.					
REM (1.S)	Introductionary days			Module **Energy and sustainable development**			Module **Natural resources**			Module **Technology I**			Christmas Break		Module **Technology I**			Module **Climate & energy Policy**			Module **Research skills**					REM (1.S)
				Schmidt			**Mayer**			**Reindl**					**Reindl**			**Schraml, Pistorius**			**Oesten,**					
				Student organized event											Student organized event											

	Winter term 2010/11- Third Semester																									
	October			November						December				January				February				March					
CW				42	43	44	45	46	47	48	49	50	51	52	01	02	03	04	05	06	07	08	09	10	11	12	cw
	.			18.10. - 05.11.			08.11 – 26.11.			29.11. – 17.12.			- 2.01.		03.01. -21.01.			24.01. – 11.02.			14.02. – 04.03.					
REM (3.S)				Module **Internship**			Module **Project**			Module **Management II**			**Christmas Break**		Module **SOE + GIS**			Module **Elective II**			Module **Case study**					
				Adler			**Becker, Oesten, Reindl, Wittwer**			**Oesten**					**Oesten**			**Becker, Reindl, Wittwer**			**Oesten**					
	Student organized event														Student organized event											

2.2. Summer term

	Summer term 2011 – Second Semester																				
		April				May					June				July			August			
CW			15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33		CW
		11.04 –29.04.			02.05.-20.05.			23.05.-10.06..			13.- 17.6	20.06 – 08.07.			11.07 - 29.07.			01.08 - .				
REM (2.S)		Module **Technology II**			Module **Manage-ment I**			Module **Elective I**			**Pentecost break**	Module **Societal framework REM**						Module **Internship**				REM (2 S)
		Reindl			**Oesten,**			**Becker, Reindl, Wittwer**				**Oesten**						**Adler**				
		Student organized event																				

3. Module descriptions

Module compendium

3.1. Winter term 2009/2010 – first semester

- **Energy and sustainable development**
- **Natural resources**
- **Technology of renewable energy utilization**
- **Climate and energy policy**
- **Research Skills**

3.2. Winter term 2009/2010 – third semester

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

3.3. Summer term 2009/2010 – second semester

- **Technology II**
- **Management I**
- **Elective I**
- **Societal framework for REM: Law, Business, Politics, Socioscientific fundamentals**
- **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. 40
Teaching form Lectures, group work, excursion	**Examination form** Seminar paper, group work presentation	**Start date** 18.10.2010	**Location** Room 200
Module coordinators: Prof. Dr. Uwe Eduard Schmidt (uwe.e.schmidt@ifp.uni-freiburg.de)			
Additional teaching staff Dr. Magdalena Steiner (magdalena.steiner@epg.uni-freiburg.de)			

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.

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 practical relevance of the concepts of sustainable development is given by the lectures of “Vision and Governance” and “Sustainability and Development Cooperation”.

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
- 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)

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

Course prerequisites

None.

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
93120	**Natural Resources**		1st Sem. / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
5 ECTS-P (150h/60 h)	---	---	max. 40
Teaching form	**Examination form**	**Start date**	**Location**
Lectures, tutorials, excursions	Written exam	08.11.2010	Room 200

Module coordinators: Prof. Dr. Helmut Mayer (helmut.mayer@meteo.uni-freiburg.de)

Additional teaching staff

Prof. Dr. Dr. h.c. Gero Becker, Prof. Dr. Kurt Bucher, Dipl.-Forstw. Benjamin Engler, Prof. Dr. Reto Gieré, Dr. Jens Lange, Prof. Dr. Andreas Matzarakis, Dr. Dirk Schindler, Prof. Dr. Weiler

Syllabus

The module provides basic knowledge on the physics of different kinds of renewable energies. They cover

- basics of atmospheric processes and phenomena of climate change (Matzarakis)
- energy meteorology (Schindler): processes, phenomena, spatial patterns and temporal patterns of radiative fluxes and air flow in the atmospheric boundary layer
- 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
- water cycle and potentials for hydropower use (Lange, Weiler): watersheds, water balance components, runoff generation, hydrological extremes, hydroelectric potentials and its regional and seasonal distribution, assessment tools for hydroelectric potentials, impacts of global change on hydroelectric potentials, basic types of hydropower use and case studies
- biomass (Becker): sources of biomass for energy, potential assessment, thermal and chemical biomass conversion processes, energy products from biomass; bioenergy and carbon balance; economical and environmental assessment of bioenergy

Learning goals and qualifications

In this module students should get an understanding on:

- the physics of different kinds of renewable energies
- spatial and temporal patterns of renewable energies
- impact factors for different kind of renewable energies
- effects of the use of renewable energies

Development of the following qualifications is supported:

- Estimation of the physical potential of different renewable energies
- Estimation of the spatial and temporal availability of different renewable energies

Recommended reading

To be delivered individually at the start of the module.
I. Stober and K. Bucher, 2009: Geothermal Energy, Geothermal Exploration. Springer Verlag, Heidelberg.

Course prerequisites

Basics in Biology, Chemistry, Forestry, Geology, Hydrology, Meteorology and Physics from previous B.Sc. courses

Course			
M.Sc. Renewable Energy Management			
Availability to other courses ---			**Instruction Language** English
Module No. **93130**	**Module name** **Technology of Renewable Energy Utilization I**		**Semester/return** 1st Sem. / annual
Workload/presence 10 ECTS (300 h/ 100 h)	**Prerequisite module(s)** ---	**Follow-up module(s)** Technology II (93210)	**No. of participants** Max. 40
Teaching form Lectures, Exercises, Seminar, lab experiments	**Examination form** Seminar presentation, written exam	**Start date** 29.11.2010	**Location** Mainly Room 200
Module coordinators: Prof. Dr. Leonard Reindl (reindl@imtek.uni-freiburg.de)			
Additional teaching staff Dr. Ralf Preu (photovoltaics), Dr. Werner Platzer (solar thermal, solar power), Prof. Dr. Peter Treffinger (thermal energy conversion), Dr. Christof Wittwer (renewable energy system technology)			

Syllabus

This double module will give an introduction into several technologies of renewable energies (continued in the module Technology II). At the beginning of the module a “Multiple Choice Test” assesses the existing knowledge in the following disciplines: Building Control , Electrical Engineering, Heat Transfer , Mathematics:, Thermodynamics,, Solid State and Semiconductor Physics. There will be sufficient time for individual rework of knowledge deficits. Support is offered by corresponding literature, individual advice, consultation hours and exercises.

1. Introduction in Lab and Instruments
   Introduction course to become acquainted with standard lap equipment (basic exercises).
2. Introduction in Renewable Energy System technology
   I. Energy, Energy Transport: (a) energy and power (b) energy transport: non-grid and grid bounded, (c) energy losses; sankey diagrams (d) energy storage, range, efficiency
   II. Plants, Storages, Distribution Grids: (a) cogeneration vs. central generation, (b) renewable plants (c) pv-systems, components, operation (d) Operation of Grids; Smart Grid (e) grids structure; load management, fluctuation
   III. Grid theory, Electro Technical Basics, Grid Calculation: (a) DC circuit calculation, (b) AC circuit calculation, (c) examples
3. Introduction in Photovoltaics
   Basics of photovoltaics, fundamental features of photovoltaic materials, generation and recombination of carriers in semiconductors, (illuminated) pn-junction, cell technology, overview on crystalline silicon, thin film and other technologies, characterization of pv devices, simple design of photovoltaic systems and calculation of energy gain.
4. Introduction in Solar Thermal Energy
   Basics of Flat plate and vacuum tube solar collector design; black and selective absorbers, background of radiative and convective heat transfer and optical gains in solar collectors; engineering calculation of solar radiation on collector; simple system concepts solar domestic hot water, solar assisted heating; hot water storage; overview of different types of solar thermal power systems using steam turbines.
5. Thermal energy conversion
   The course covers energy conversion technologies based on thermal processes. First, an overview on technologies widely used in the energy sector for conversion of fossil fuel is given. Following that technologies fitting to smaller scale decentralized power plants applying primary energy sources like biomass (solid wood, wood chips,and pellet operated power stations), solar energy and waste heat as well are treated. Some representative applications of such power plants given.

Learning goals and qualifications

1. Introduction in Lab and Instruments
   Students will learn about the function of common laboratory instruments, the use of signal processing and control software.
2. Introduction in Renewable Energy System technology
   Basics of designing grid integrated energy systems; fundamental aspects of power and energy definition, overview on plant technologies, calculation and simulation of energy systems; fundamental aspects of power flow calculation and grid theory.
3. Introduction in 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 IV-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.
4. Introduction in Solar Thermal Energy
   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 quantitative simple calculations of collector performance factors will be practised.
5. Thermal energy conversion
   The course shall enable the students to pursue decision processes in order to identify suitable thermal conversion technologies for a given application and shall enable them to estimate capacity parameters. The students will learn the working principles and the advantages/disadvantages of different wood-based power plant technology.

Recommended reading

Duffie-Beckman: Solar Engineering of Thermal Processes.
Paul A. Lynn, Electricity from Sunlight: An Introduction to Photovoltaics
Martin Green: Solar Cells: Operating Principles, Technology, and System Applications.
Peter Würfel: Physics of Solar Cells
Markvart, T., Solar Electricity
Quaschning, V.: Renewable Energy and Climate Change. John Wiley & Sons Ltd Chichester, ISBN 978-0-470-74707-0, 1st edition 2010.

Course prerequisites

Basics in Biology, Chemistry, Mathematics and Physics from a previous B.Sc. course

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. 40
Teaching form	**Examination form**	**Start date**	**Location**
Lectures + group work assignments	Written test + group work presentations	24.01.2011	Room 200

Module coordinators: Prof. Dr. Ulrich Schraml, Dr. Till Pistorius (till.pistorius@ifp.uni-freiburg.de)

Additional teaching staff: external guest speakers

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. By analyzing the scientific background of these conflicts as well as the interests of the actors involved, the students will be sensitized for the complexity of these issues and be prepared for evaluating possible solution strategies.
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.a. by

- conducting country case studies,
- panel discussions with different actors (role plays)
- preparation of short presentations on issues of special interest.

Furthermore, various guest speakers and experts from different fields and institutions (ministries, industry, ENGO etc) 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 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.

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. Camebridge university press. 350 p
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. **93320**	**Module name** **Research Skills**		**Semester/return** 1st Sem. / annual
Workload/presence 5 ECTS-P (150h/60 h)	**Prerequisite module(s)** --	**Follow-up module(s)** ---	**No. of participants** max. 40
Teaching form Lecture/ group work	**Examination form** Poster presentation and paper submission	**Start date** 14.02.2011	**Location** Room 200

Module coordinators:

Prof. Dr. Dr. h.c. Gerhard Oesten (g.oesten@zee.uni-freiburg.de) ,

Additional teaching staff

Dr. Ramchandra Bhandari, Dr. Sandra Rajmis

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.

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. 40
Teaching form	**Examination form**	**Start date**	**Location**
Practical work	Written report	August 2010	t.b.a.

Module coordinators: Prof. Dr. Dr. h.c. Gerhard Oesten (g.oesten@zee.uni-freiburg.de), Dipl.-Biol. Stefan Adler (stefan.adler@zee.uni-freiburg.de)

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.

<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
3. 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. 40</td></tr>
<tr><td>Teaching form
Seminar, self study, students presentation</td><td>Examination form
Written report</td><td>Start date
03.01.2011</td><td>Location
t.b.a.</td></tr>
<tr><td colspan="4">Module coordinators:
Prof. Dr. Dr. h.c. Gerhard Oesten (g.oesten@zee.uni-freiburg.de)</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.
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. 40</td></tr>
<tr><td>Teaching form
Lectures, Exercises, Case studies, Seminar</td><td>Examination form
Seminar presentation, written exam</td><td>Start date
29.11.2010</td><td>Location
Room 100</td></tr>
<tr><td colspan="4">Module coordinators Prof. Dr. Dr. h.c. Gerhard Oesten (g.oesten@zee.uni-freiburg.de),</td></tr>
<tr><td colspan="4">Additional teaching staff: Dr. Ramchandra Bhandari (ramchandra.bhandari@zee.uni-freiburg.de);
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. **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. 40
Teaching form Workshop, Group work	**Examination form** Presentations in pitch rounds	**Start date** To be determined by the students	**Location** To be determined by the students
Module coordinators: Prof. Dr. Dr. h.c. G. Oesten (g.oesten@zee.uni-freiburg.de)			
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.

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)	Elective I	---	Max. 15
Teaching form	**Examination form**	**Start date**	**Location**
Lectures, excursions	Written Exam	24.01.11	T.b.a.
Module coordinators: Prof. Dr. Dr. h.c. Gero Becker (institut@fobawi@uni-freiburg.de)			
Additional teaching staff			
Dr. Aicher, Dr. Rochlitz, Prof. Dr. Spiecker, Engler			

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 II Energy Efficiency – 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, group work, excursion	**Examination form** Group work, written exam, presentation,	**Start date** 24.01.11	**Location** T.b.a.
Module coordinators: Prof. Dr.Leonhard Reindl (reindl@imtek.uni-freiburg.de), Dipl. Ing. Andreas Rettenmeier (rettenmeier@ifb.uni-stuttgart.de) - acting head of the Endowed Chair of Wind Energy (Stiftungslehrstuhl Windenergie (SWE)), Stuttgart			
Additional teaching staff Dipl. Ing Stefan Baehr (baehr@ifb.uni-stuttgart.de) and MSc. BME. Mark Capellaro (capellaro@ifb.uni-stuttgart.de), Endowed Chair of Wind Energy, Stuttgart			

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. The module will introduce the aspects of wind relevant to wind energy, and will cover the necessary statistical procedures used to describe the wind. The students will then be familiarized with the physics of producing energy from the wind including some basic fluids and aerodynamics in order to introduce the Betz limit. The mechanics and types of turbines will also be explained to allow students to understand some of the economic choices wind turbine engineers must make. The final component of the module will introduce the concept of wind park planning. These subjects will give the students the information necessary to successfully complete the Wind Energy Project.

- Wind and statistical tools used to describe the wind (Weibull, wind shear, measurement techniques)
- Physics of a wind turbine including the Betz limit
- The mechanics of wind turbine and turbine types (power curve, capacity factor, simulations)
- Wind park planning (siting, marine environments, noise concerns)

The concept of wind energy is best introduced by a short primer about the wind itself. This allows the student to understand the stochastic nature of the wind and demonstrates this variation of the wind as one of the chief challenges of creating affordable power from the wind. The introduction to wind will concentrate on the measuring of the wind and the various techniques used. The SWE will be able to provide several types of anemometers for the students to get a 'hands on' feel for the measurement tools. The statistical description of the wind via the Weibull distribution and wind shear profile are introduced. Students will be encouraged to find wind data about their home country for use later in the Wind Energy Module Project.

The second component of the module will introduce the physics behind creating torque and eventually power from the wind. The goal is to describe in briefly the aerodynamics of a wind turbine, focusing on the blades and how the aerodynamics of a wind turbine blade convert the oncoming wind to torque. The SWE will provide blade sections and scaled blades to again give some 'hands on' material to help explain the concepts.

The third component of the module is the details of the turbine itself. Since there are various turbine models and designs, this will include some of the economic reasoning behind the design decisions of turbine engineers. Relevant topics will include; stall vs. pitch wind turbines, direct drive vs. geared turbine, and monopole towers vs. truss towers.

The final component will be wind park planning and the concerns regarding the installation and operation of wind turbines. The topics to be discussed are: spacing of turbine and shadowing, noise considerations, 'visual

pollution' and other topics relevant to the siting of turbines and wind parks including costs. Students will be encouraged to find information from their home countries regarding cost of energy (kWh costs and any wind related wind feed in tariffs, bonuses…).

The Wind Energy Module is also to include a field trip to a local wind turbine in Dunningen, BaWü (weather permitting) and a visit to the SWE in Stuttgart, Germany's first research chair in wind energy. In Stuttgart the students will be given an introduction to the various research fields in wind energy and they will be given a short tutorial on the WindPro wind park planning software.

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

Learning goals and qualifications

- Understanding of the stochastic nature of the wind and the statistic parameters used to summarize the wind.
- Introduction to the physics and mechanics of converting wind to torque/electricity and the physical limits.
- Basic understanding of the various turbine typologies and economic reasoning behind the types.
- Fundamental understanding of the issues involved with wind park planning, including the necessity to understand local conditions, including social/political/environmental issues.
- Additional general skills: rhetoric, discussion and presentation skills, capacity for team work

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

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 20</td></tr>
<tr><td>Teaching form
Lectures, exercises, student presentations</td><td>Examination form
Written exam plus presentation or report</td><td>Start date
24.01.11</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>

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
93210	**Technology II incl. Energy Efficiency**		2nd Sem./ annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
5 ECTS/(100h/50h)	Technology I	Elective modules	Max. 40
Teaching form	**Examination form**	**Start date**	**Location**
Lectures, excursions, case study	Presentation + Report	11.04.2011	Mainly Room 200

Module coordinators: Prof. Dr.Leonhard Reindl (reindl@imtek.uni-freiburg.de)

Additional teaching staff

Prof. Dr. Dr. h.c. Gero Becker, Benjamin Engler (biomass), Dr. Georg Löser (hydro power), Dr. Josef Pesch (wind energy)

Syllabus

1. Bio Energy

   Aim of this module is, 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).
   An excursion to advanced conversion sites will be part of the module.

2. Hydropower

   This 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 specific 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 (Internat. 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. An excursion day to a producing company of hydropower machinery, and to a small and a large hydropower station will be part of the module.

3. Wind Energy

   This module gives an applied overview about wind technology, focusing on performance and feasibility. Main topics are: the evolution of the wind turbine (capacity, components), legal framework (EEG) 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.

Learning goals and qualifications

1. Bio Energy
   Within this module 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 and trained.
2. Hydropower
   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. 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.
3. Wind Energy
   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.

Recommended reading

Richardson, J. (2002): Bioenergy from sustainable forestry: guiding principles and practice: Kluwer Academic. 344 S.

Additional relevant literature will be presented in the module

Course prerequisites

Content of the module “Technology of renewable energy utilization”.

<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.
93220</td><td colspan="2">Module name
Management I</td><td>Semester/return
2nd Sem. / annual</td></tr>
<tr><td>Workload/presence
5 ECTS-P (150h/60 h)</td><td>Prerequisite module(s)
--</td><td>Follow-up module(s)
Management II</td><td>No. of participants
max. 40</td></tr>
<tr><td>Teaching form
Lectures, Exercises, Seminar</td><td>Examination form
Seminar presentation, written exam</td><td>Start date
02.05.2011</td><td>Location
Room 200</td></tr>
<tr><td colspan="4">Module coordinators Prof. Dr. Dr. h.c. Gerhard Oesten (g.oesten@zee.uni-freiburg.de),</td></tr>
<tr><td colspan="4">Additional teaching staff: Dr. Ramchandra Bhandari (ramchandra.bhandari@zee.uni-freiburg.de);
Dr. Roderich von Detten (r.v.detten@ife.uni-freiburg.de</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td colspan="4">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 Campus Online</td></tr>
<tr><td colspan="4">Course prerequisites
None.</td></tr>
</table>

Course			
M.Sc. Renewable Energy Management			
Availability to other courses			**Instruction Language**
---			English
Module No.	**Module name**		**Semester/return**
93931	**Elective I - Bioenergy**		2nd Sem. / annual
Workload/presence	**Prerequisite module(s)**	**Follow-up module(s)**	**No. of participants**
5 ECTS-P (150 / 60h)	Technology I,II	Elective II	Max. 15
Teaching form	**Examination form**	**Start date**	**Location**
Lectures, excursions	Written Exam	23.05.2011	T.b.a.

Module coordinators: Prof. Dr. Dr. h.c. Gero Becker (institut@fobawi@uni-freiburg.de)

Additional teaching staff: Prof. Dr. Marie-Pierre Laborie, Prof. Dr. Joachim Jochum, Dr. Mastel, Benjamin Engler.

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.
93901</td><td colspan="2">Module name
Elective I Energy Efficiency</td><td>Semester/return
2nd / annual</td></tr>
<tr><td>Workload/presence
5 ECTS-P (150/60h)</td><td>Prerequisite module(s)
Technology I and II</td><td>Follow-up module(s)
Elective II Energy Efficiency</td><td>No. of participants
Max. 20</td></tr>
<tr><td>Teaching form
Lecture, exercises, lab</td><td>Examination form
Written exam, exercise or lap report</td><td>Start date
23.05.2011</td><td>Location
T.b.a.</td></tr>
<tr><td colspan="4">Module coordinators: Prof. Dr. Leonhard Reindl (reindl@imtek.uni-freiburg.de), Prof. Elmar Bollin (bollin@fh-offenburg.de)</td></tr>
<tr><td colspan="4">Additional teaching staff</td></tr>
<tr><td colspan="4">Syllabus
In this module the students will learn about energy efficiency of
• cogenerated systems
• electro thermal power generation
• energy distribution systems and energy storage
• solar power generation systems, function and their limitations
• power storage and distribution as well as future developments in solar power generation
• smart wireless control for power generation systems: how these systems work, how these systems are powered from the ambient environment and managed. How these wireless systems intercommunicate and transmit data. Sensors and actuators used in these systems. Future developments in smart wireless control for power generation systems
Building automation will be introduced as an important tool to analyse building energy performance and to operate building technologies by means of advanced building automation tools like remote control and weather forecasting.</td></tr>
<tr><td colspan="4">Learning goals and qualifications
In this course, students will learn about energy efficiency of power storage and distribution, energy distribution systems, control systems using smart wireless sensors for optimization of power generation systems, micro energy harvesting (incl. storage and management systems), embedded systems, sensors and actuators.

Students will learn to use building automation to optimize building operation, to analyse structural plans of digital building control and to parameterize co0ntol cycles of systems for building services.</td></tr>
<tr><td colspan="4">Recommended reading
Everything provided in lecture and lab</td></tr>
<tr><td colspan="4">Course prerequisites
Content of the modules Technology I and II.</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.
93911</td><td colspan="2">Module name
Elective I
Photovoltaic & Solar Thermal Energy</td><td>Semester/return
2nd Sem. / annual</td></tr>
<tr><td>Workload/presence
5 ECTS-P (150/60h)</td><td>Prerequisite module(s)
Technology I and II</td><td>Follow-up module(s)
Elective II Photovoltaic and solar thermal energy</td><td>No. of participants
Max. 20</td></tr>
<tr><td>Teaching form
Lectures, Exercises</td><td>Examination form
Exam</td><td>Start date
23.05.2011</td><td>Location
Fraunhofer ISE</td></tr>
<tr><td colspan="4">Module coordinators: Prof. Dr. Volker Wittwer (volker.wittwer@ise.fraunhofer.de), Dr. Ralf Preu (ralf.preu@ise.fraunhofer.de)</td></tr>
<tr><td colspan="4">Additional teaching staff: N.N.</td></tr>
<tr><td colspan="4">Syllabus
• Basics of semiconductor physics
• Photogeneration and recombination, carrier transport
• pn-Junction and IV-characteristics
• Silicon: Quartz, metallurgical silicon, crystallization, wafer cutting
• Industrial silicon solar cell production
• Module technology
• Cost of ownership
• Characterization of cells / material
• Loss mechanisms and improvements
• High efficiency cell concepts</td></tr>
<tr><td colspan="4">Learning goals and qualifications
As the first step in this course the student will get an overview about the basic concepts of semiconductors. This is the prerequisite for the understanding of the principles of solar cell physics which is one of the main topics of this course. Subsequently the student will study the whole production chain of silicon solar cells starting from quartz via solar cell production to module fabrication. This will be accompanied by an in-depth cost analysis of the solar cell production. The students will understand main loss mechanisms of silicon solar cells and the advantages of high-efficiency cell concepts.</td></tr>
<tr><td colspan="4">Recommended reading
1. B. Streetman, Solid State Electronic Devices
2. S.M. Sze, Physics of Semiconductor Devices
3. Martin A. Green, Solar Cells: Operating Principles, Technology, and System Applications
4. Peter Würfel, Physics of Solar Cells
5. A. Goetzberger, B. Voß, J. Knobloch, Crystalline Silicon Solar Cells: Technology and Systems Applications
6. Jenny Nelson, The Physics of Solar Cells,</td></tr>
<tr><td colspan="4">Course prerequisites
Basic knowledge of semiconductor physics (B.Streetman, Solid State Electronic Devices).
Content of the modules Technology I and II.</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.
93230</td><td colspan="2">Module name
Societal framework for REM</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. 40</td></tr>
<tr><td>Teaching form
Lectures, Exercises, Excursions, Case studies, Seminar</td><td>Examination form
Seminar presentation, written exam</td><td>Start date
20.06.2011</td><td>Location
Room 200</td></tr>
<tr><td colspan="4">Module coordinators: Prof. Dr. Dr. h.c. Gerhard Oesten (g.oesten@zee.uni-freiburg.de),</td></tr>
<tr><td colspan="4">Additional teaching staff Dr. Ramchandra Bhandari (ramchandra.bhandari@zee.uni-freiburg.de); N.N.</td></tr>
<tr><td colspan="4">Syllabus
• Introduction to the societal frame of REM – an overview
• The economic environment – energy markets, energy supply systems, regional economy, services
• Basics of environmental economics
• 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 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 Campus Online</td></tr>
</table>

Course prerequisites

Content of the modules “Management I” and “Climate and Energy Policy”.

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. 40
Teaching form	**Examination form**	**Start date**	**Location**
Practical work	Written report	01.08.2011	t.b.a.

Module coordinators: Prof. Dr. Dr. h.c. Gerhard Oesten (g.oesten@zee.uni-freiburg.de), Dipl.-Biol. Stefan Adler (stefan.adler@zee.uni-freiburg.de)

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.