Modul 37: Renewable Energy Technologies B

Studiengang / course:	M.Eng. Energie- und Umweltmanagement / M.Eng. Energy and Environmental Management
Modulbezeichnung / module name:	Renewable Energy Technologies B
ggf. Kürzel / abbreviation	RET B
ggf. Untertitel / subtitle	-------
ggf. Lehrveranstaltungen / seminar:	Up to two workgroups to be selected. Regularly offered: Solar Energy, Wind Energy, Hydropower, Biomass, Grid Integration of RET
Semester / semester:	Spring Term
Modulverantwortliche(r) / person in charge of module:	Dipl.-Ing. Wuf Boie
Dozent(in) / person teaching the seminar:	Prof. Jens Born Prof. Clemens Jauch Dr. Hermann van Radecke Dipl.-Ing. Wulf Boie N.N.
Sprache / language:	English
Zuordnung zum Curriculum / attribution to courses:	M.Eng. Energy and Environmental Management for ‘Developing countries’: Core Elective Course
Lehrform / SWS / form of seminar / teaching hours per week:	The module follows the problem-based learning approach: After a general introduction to renewable energy technologies and a more extended introduction to two specific technologies, to be selected by the students, problems are assigned to work groups of students. The students identify what their learning requirements are, acquire the knowledge they need and apply it to solve the problem. The lecturers serve as coaches/advisers/facilitators, designing the learning environment and delivering inputs on request of the students. Students can participate in up to two workgroups. Contact hours per week: 8
Arbeitsaufwand / student workload:	300 hours workload
Kreditpunkte / credit points:	10 ECTS
Voraussetzungen nach Prüfungsordnung/ preconditions according to examination regulations:	none
Modulziele / angestrebte Lernergebnisse / aims of the module / aspired learning outcome:	The students - have fundamental knowledge of the most important renewable energy technologies - are able to generate present and future load profiles - have deeper knowledge of at least one renewable energy technology - know how to assess local RE resources - are able to carry out a preliminary technical design of selected RET

	- are capable to assess the feasibility of RET - are aware of the structure of the technical planning process for a rural renewable energy system - are able to present, communicate and document their work results - have developed strategies to acquire/apply knowledge in order to solve a techno-economical problem - have constructed a flexible knowledge base in at least on field of renewable energy - have developed problem solving skills - have developed self-directed, life-long learning skills
Inhalt / subjects covered:	All participants participate in a general introduction to • Wind Energy, • Hydropower, • Solar Energy, • Bio Energy, • Grid Integration of Renewable Energy Technologies of 4 contact hours each. Thereafter each student participates in two work groups to specialize in up to two of the above mentioned subjects. The work groups are confronted with a real life technical case study (resp. a problem) of designing renewable energy systems. Under the guidance of the lecturer the students follow the general ‘Seven-Jump’ method for problem based learning (after Gijselaers, 1995): • Clarify terms and concepts not readily comprehensible • Define the problem • Analyse the problem and offer tentative explanations • Draw up an inventory of explanations • Formulate learning objectives • Collect further information through private study • Synthesize the new information and evaluate and test it against the original problem. Reflect on and consolidate learning. The students can request the lecturer to provide lectures on specific contents. The lecturer can decide to provide a series of lectures as a more specific introduction before the group work starts, if this is necessary to understand the case study. The case studies represent real life problems which were identified by the students themselves, provided by alumni of the programme or which arise from research activities of the lecturers. All case studies should include the following aspects as far as applicable: • Resource assessment • Assessment of generation profile • Technology assessment and selection • Selection, design and dimensioning of technology • Economic and Environmental Assessment

	As far as available the application of industry standard design software should be part of all case studies. The work group on Grid integration should cover the following aspects: • Basics of electrical systems: current, voltage, power, energy, power factor, losses on line, capacitance, inductance, transformers, generator, Transmission lines of different voltage levels (overhead lines and underground cables), electrical network design. • Power Quality: harmonics, flicker, voltage dips, Transients voltage dips and frequency variations • The principle of maintaining the balance between generation and demand • Preliminary analysis for integration of renewable technologies to the electricity grids: power flow analysis, short circuit analysis, stability studies and covering a given load profile. A typical case study can for example be the replacement of fossil fuels by renewable energy technologies in an isolated rural grid. In that case different work groups (e.g. wind, solar, hydro, grid integration) would have to cooperate and integrate their work results at the end.
Studien- Prüfungsleistungen / form of examination:	The groups document their active participation in weekly progress reports. In each plenary meeting the groups will report on their project progress. Each group will present their results in the last week of the semester and submit a project report, based on the weekly progress reports (6-8 pages per student). The individual contributions to the report have to be distinguishable. Assessment - Group mark for final presentation and documentation: 40% - Individual mark for final presentation and documentation: 60%
Medienformen / media used:	Black-/ whiteboard, Power point presentations, Software simulation tools
Literatur / literature:	Wind Energy - Manwell, J. F. et. al.: Wind Energy Explained., Chichester, 2009 - Burton, T.: Wind energy handbook, Chichester, 2002 - Troen, I., Petersen, E. L.: European Wind Atlas. Risoe Nat. Lab., 1991, - Gasch, R., Twele, J.: Wind Power Plants. Fundamentals, Design, Construction and Operation. Solarpraxis AG, Berlin, 2002 Hydropopwer - Harvey, A. (2002): Micro-Hydro Design Manual, ITPublications Ltd., London (Library) - DCS - Technology Development (1998): Manual for Survey and Layout Design of Private Micro-hydropower Plants, International Centre for Integrated Mountain Development (ICIMOD)Kathmandu, Nepal (BSCW)

	- European Small Hydropower Association (2004): Guide on how to develop a small hydro site (Moodle) Bio energy - Jay Cheng (2009): Biomass to Renewable Energy Processes; CRC Press - Sergio Capareda (2013): Introduction to Biomass Energy Conversions; CRC Press - Tim Pullen (2015): Anaerobic Digestion - Making Biogas - Making energy; Routledge - Dieter Deublein, Angelka Steinhauser (2010): Biogas from Waste and Renewable Resources: An Introduction: 2nd Edition; Wiley-VCH Solar Energy - Konrad Mertens (2013): Photovoltaics: Fundamentals, Technology and Practice - Geoff Stapleton (2012): Grid-Connected Solar Electric Systems - Chen, C. Julian Physics of Solar Energy - Klaus Jäger, Olindo Isabella, Arno H.M. Smets, René A.C.M.M. van Swaaij, Miro Zeman (2014): Solar Energy: Fundamentals, Technology, and Systems Grid Integration - B.M. Weedy, B.J. Cory; Electric Power Systems; John Wiley - S. Heier; Grid Integration of Wind Energy Conversion Systems; John Wiley & Sons