

## Modules for Postgraduate Programme Renewable Energy

Date 10/12/19

### Mastermodule

#### pre011 - Fundamentals of Renewable Energy

<b>Module label</b>	Fundamentals of Renewable Energy			
<b>Module code</b>	pre011			
<b>Credit points</b>	12.0 KP			
<b>Workload</b>	360 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	MM (Mastermodul / Master module)			
<b>Modulart</b>	Pflicht / Mandatory			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>	2 Prüfungsleistungen: Fachpraktische Übungen (Versuchsprotokolle und Übungsaufgaben, Gewicht: 75%) und entweder Hausarbeit (10-15 Seiten) oder Präsentation (15-20 min, Gewicht: 25%)			
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe and WiSe	28 h
Exercises		4.00	SuSe and WiSe	56 h
<b>Total time of attendance for the module</b>				<b>84 h</b>

## pre021 - Energy Resources and Systems

<b>Module label</b>	Energy Resources and Systems	
<b>Module code</b>	pre021	
<b>Credit points</b>	6.0 KP	
<b>Workload</b>	180 h	
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>	
<b>Contact person</b>		
<b>Entry requirements</b>		
<b>Skills to be acquired in this module</b>		
<b>Module contents</b>		
<b>Reader's advisory</b>		
<b>Links</b>		
<b>Languages of instruction</b>	German, English	
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>		
<b>Module capacity</b>	unlimited	
<b>Modullevel</b>	MM (Mastermodul / Master module)	
<b>Modulart</b>	Pflicht / Mandatory	
<b>Lern-/Lehrform / Type of program</b>		
<b>Vorkenntnisse / Previous knowledge</b>		
<b>Examination</b>	Time of examination	Type of examination
<b>Final exam of module</b>		1 Prüfungsleistung: Klausur (2h)
<b>Course type</b>	Lecture	
<b>SWS</b>	4.00	
<b>Frequency</b>	SuSe and WiSe	
<b>Workload attendance</b>	56 h	

## pre031 - Renewable Energy Technologies I

<b>Module label</b>	Renewable Energy Technologies I			
<b>Module code</b>	pre031			
<b>Credit points</b>	12.0 KP			
<b>Workload</b>	360 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Pflicht / Mandatory			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			2 Prüfungsleistungen: Klausur (3h, Gewicht 75%) sowie Referat (15 min. Präsentation, 15 Seiten Bericht, Gewicht 25%).	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		4.00	SuSe and WiSe	56 h
Exercises		4.00	SuSe and WiSe	56 h
<b>Total time of attendance for the module</b>				112 h

## pre041 - Sustainability of Renewable Energy

<b>Module label</b>	Sustainability of Renewable Energy			
<b>Module code</b>	pre041			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Pflicht / Mandatory			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			1 Prüfungsleistung: Hausarbeit (20 Seiten) oder Referat (Präsentation - 45 Minuten und Ausarbeitung 10 Seiten)	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	WiSe	28 h
Seminar		2.00	SuSe and WiSe	28 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

## pre051 - Renewable Energy Systems Laboratory and Modelling

<b>Module label</b>	Renewable Energy Systems Laboratory and Modelling			
<b>Module code</b>	pre051			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Language of instruction</b>	German			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Pflicht / Mandatory			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			1 Prüfungsleistung: Konferenzbeitrag (siehe Ergänzung zu „§ 11 Abs. (15) )	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe and WiSe	28 h
Werkstatt/Labor		2.00	SuSe and WiSe	28 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

## pre071 - Internship

<b>Module label</b>	Internship			
<b>Module code</b>	pre071			
<b>Credit points</b>	9.0 KP			
<b>Workload</b>	270 h			
<b>Used in course of study</b>	• Master's Programme Postgraduate Programme Renewable Energy (Master) > Mastermodule			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Pflicht / Mandatory			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			1 Prüfungsleistung: Referat (Präsentation+ Diskussion (20min) und Praktikumsbericht (20 Seiten) )	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Seminar		2.00	SuSe and WiSe	28 h
Practical		4.00	SuSe and WiSe	56 h
<b>Total time of attendance for the module</b>				<b>84 h</b>

## pre061 - Renewable Energy Complementary Topics

<b>Module label</b>	Renewable Energy Complementary Topics			
<b>Module code</b>	pre061			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination	Type of examination		
<b>Final exam of module</b>		<p>2 Prüfungsleistungen: Das Modul ist unbenotet, jedoch müssen 2 der möglichen Kurse mindestens als ‚bestanden‘ gewertet werden um das Modul zu bestehen. Mögliche Prüfungsformen sind:</p> <p>Klausur (1 h), mündliche Prüfung (20 min), Referat (10 Seiten Ausarbeitung + 10 Minuten Präsentation), Hausarbeit (max. 20 Seiten), fachpraktische Übung (max. 8), Seminararbeit (max. 20 Seiten), Portfolio, Präsentation (15 min.)</p> <p>In Seminaren wird Aktive Teilnahme (siehe Ergänzung zu „§ 9 Abs. (6) ) gefordert..</p>		
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe and WiSe	28 h
Seminar und Übung		2.00	SuSe and WiSe	28 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

## pre081 - Renewable Energy Project

<b>Module label</b>	Renewable Energy Project			
<b>Module code</b>	pre081			
<b>Credit points</b>	9.0 KP			
<b>Workload</b>	270 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Pflicht / Mandatory			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			1 Prüfungsleistung: (Gruppen-) Referat (Präsentation 15min und Projekt-Bericht ~15 Seiten)	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe and WiSe	28 h
Seminar		2.00	SuSe and WiSe	28 h
Study trip		2.00	SuSe and WiSe	28 h
<b>Total time of attendance for the module</b>				<b>84 h</b>



## pre111 - Photovoltaic Physics

<b>Module label</b>	Photovoltaic Physics			
<b>Module code</b>	pre111			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			1 Prüfungsleistung: Fachpraktische Übungen (max. 8)	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe and WiSe	28 h
Exercises		2.00	SuSe and WiSe	28 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

## pre112 - Photovoltaics Systems & Solar Energy Meteorology

<b>Module label</b>	Photovoltaics Systems & Solar Energy Meteorology			
<b>Module code</b>	pre112			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			G	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe and WiSe	28 h
Seminar		2.00	SuSe and WiSe	28 h
<b>Total time of attendance for the module</b>				56 h

## pre121 - Wind Energy Converters & Fluid Dynamics

<b>Module label</b>	Wind Energy Converters & Fluid Dynamics			
<b>Module code</b>	pre121			
<b>Credit points</b>	12.0 KP			
<b>Workload</b>	360 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			1 Prüfungsleistung: Klausur (3h) oder Präsentation (30 min.) oder mündliche Prüfung (45 min.) oder fachpraktische Übungen (max. 10) oder Hausarbeit (max. 30 Seiten)	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		4.00	SuSe and WiSe	56 h
Exercises		4.00	SuSe and WiSe	56 h
<b>Total time of attendance for the module</b>				112 h

## pre131 - Design and Simulation of Wind Turbines

<b>Module label</b>	Design and Simulation of Wind Turbines	
<b>Module code</b>	pre131	
<b>Credit points</b>	12.0 KP	
<b>Workload</b>	360 h	
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>	
<b>Contact person</b>		
<b>Entry requirements</b>		
<b>Skills to be acquired in this module</b>		
<b>Module contents</b>		
<b>Reader's advisory</b>		
<b>Links</b>		
<b>Languages of instruction</b>	German, English	
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>		
<b>Module capacity</b>	unlimited	
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)	
<b>Modulart</b>	Wahlpflicht / Elective	
<b>Lern-/Lehrform / Type of program</b>		
<b>Vorkenntnisse / Previous knowledge</b>		
<b>Examination</b>	Time of examination	Type of examination
<b>Final exam of module</b>		1 Prüfungsleistung: Klausur (3h) oder Präsentation (30 min.) oder mündliche Prüfung (45 min.) oder fachpraktische Übungen (max. 10) oder Hausarbeit (max. 30 Seiten)
<b>Course type</b>	Lecture	
<b>SWS</b>	6.00	
<b>Frequency</b>	SuSe and WiSe	
<b>Workload attendance</b>	84 h	

## pre141 - System Integration of Renewable Energy

<b>Module label</b>	System Integration of Renewable Energy
<b>Module code</b>	pre141
<b>Credit points</b>	12.0 KP
<b>Workload</b>	360 h (360 hours)
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>
<b>Contact person</b>	Module responsibility <ul style="list-style-type: none"> <li>Sebastian Lehnhoff</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	After successful completion of the module students should be able to: <ul style="list-style-type: none"> <li>explain the management, modelling and power balancing within future electricity grid configurations with high shares of fluctuating and distributed generation and the requirements for successful application to real power balancing regarding capacity utilization, robustness, and flexibility.</li> <li>appraise the main components (incl. chemical storage options) involved in future AC-grid concepts, to soundly assess the reciprocal constraints between them to propose solutions for improving its performance.</li> <li>explain necessary IT- and process control technology components, methods and processes to control and operate electrical energy systems.</li> <li>estimate and evaluate the requirements and challenges of ICT and computer science which are caused by the development and integration of unforeseeable fluctuations of decentralised plants.</li> <li>explain necessary conversion procedures and to judge the ecologic and economic balance</li> <li>categorise different grid-designs, including mini- and micro-grids</li> <li>compare different electricity markets existing currently (Futures Market, Day-Ahead-Market, Intraday-Market, Balancing Power Market, Self-Consumption) based on the motivation, role, advantages and limiting factors and to critically judge and assess the suitability of these concepts for promoting the implementation of higher shares of fluctuating distributed power generation within the electricity grid.</li> <li>explain the technical principles and resulting limiting factors for different components required for power control within "Smart City", "Smart Grid", "Smart Home" concepts, estimate the influence of distributed control concepts and algorithms for decentralised plants and consumers in the so called Smart Grid energy systems and analyse their safety, reliability, real time capability and flexibility</li> </ul>
<b>Module contents</b>	<p>The module is designed to give specialized insight on the management, modelling and power balancing within future grid configurations. It gives the students a thorough overview on the challenges and solutions in electricity grids that shall accommodate a high share of fluctuating distributed generation. It deals with the technical and economic framework for a permissible electrical network as well as mathematical modelling and calculation methods to analyse conditions of electrical energy networks (in stationary conditions). Technology, economical energy industry and technical basic knowledge and methods are analysed by using concrete Smart Grid approaches. The basic calculation methods for an intelligent net management are introduced.</p> <p>Future Power Supply Systems (Lecture &amp; Seminar – 180 h workload):</p> <ul style="list-style-type: none"> <li>Technology and characteristics of conventional power plants based e. g. on coal, gas, and nuclear</li> <li>Fundamentals, structure, technologies and operation of (AC-) electricity grids (incl. balancing power, voltage management, etc.)</li> <li>Fluctuating distributed generation: Characteristics and solutions on the transmission and distribution grid levels, incl. storage, vehicle-to-grid-concepts, smart inverters, heat pumps / CHP, etc.</li> <li>Interactions between technology and economics: The different electricity markets (Futures Market, Day-Ahead-Market, Intraday-Market, Balancing Power Market, Self-Consumption) and their links to the physical world</li> <li>"Smart City", "Smart Grid", "Smart Home"</li> <li>Mini- and Micro-Grids</li> <li>Energy scenarios and modelling</li> <li>Chemical energy carriers in the energy system: power-to-gas (e.g. methane) and power-to-liquids (e.g. methanol)</li> </ul> <p>Smart grid management (Lecture and Exercises – 180 h workload):</p> <ul style="list-style-type: none"> <li>Organisation of the EU energy market (regulatory framework, responsibility in liberalisation of electrical energy systems)</li> <li>Establishment and operation of electrical energy supply networks (network topology, statutory duties of supply, supply quality/system services, malfunctions and protection systems)</li> <li>Network calculation (complex pointer, effective/idle power, mathematical performance models/net model, transformation: node performance to node voltage and electricity, calculation of conductive current, power-flow calculation, fix-point-iteration, Newton-Raphson-Method, voltage drop, transformer</li> </ul>

model)

- Intelligent network management (Smart Grids), Aggregation forms, machine learning approaches)
- Detailed description of involved balance of system components (e.g. inverter, charge controllers)
- System Operation
- Detailed System Design – from meteorological input across component rating to energy service output

**Reader's advisory**

Future Power Supply Systems:

- Buchholz, B.M., Styczynski Z. (2014). Smart Grids - Fundamentals and Technologies in Electricity Networks. Springer Ed.
- Khartchenko, N. et al. (2013). Advanced Energy Systems, Second Edition (Energy Technology). CRC Press Inc.
- Hemami, A. (2015). Electricity and Electronics for Renewable Energy Technology: An Introduction (Power Electronics and Applications) CRC Press.
- Schlögl, R. (2013) Ed., Chemical Energy Storage, De Gruyter

Smart grid management:

- Konstantin, P.: „Praxisbuch Energiewirtschaft“, Springer 2006
- Schwab, A.: „Elektroenergiesysteme“, Springer 2009
- Kirtley, J. L.: „Electric Power Principles“, John Wiley & Sons, 2010
- Gremmel, H.: „ABB Schaltanlagen-Handbuch“, Cornelsen, 2007
- Lehnhoff, S.: „Dezentrales vernetztes Energiemanagement“, 2010
- Sutton, R. S.; Barto, A. G.: „Reinforcement Learning“, MIT Press, 1998

**Links**

<b>Language of instruction</b>	English
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	once a year
<b>Module capacity</b>	unlimited
<b>Reference text</b>	Helpful previous knowledge: <ul style="list-style-type: none"> <li>• For the course "Smart grid management" is basic knowledge in Python Programming advisable.</li> <li>• Basic knowledge on chemical processes (Chemistry-Primer: 1CP) and energy storage (course "Energy storage") are also advantageous.</li> <li>• Knowledge in Semiconductor Physics is desired (Semiconductor Physics Primer: 1CP)</li> </ul>

<b>Modullevel</b>	MM (Mastermodul / Master module)
<b>Modulart</b>	Wahlpflicht / Elective
<b>Lern-/Lehrform / Type of program</b>	Lectures, Exercises, Seminar

**Vorkenntnisse / Previous knowledge**

Examination	Time of examination	Type of examination
<b>Final exam of module</b>		2 Examinations Report (presentation: 50 min, paper: 5 pages) or Exercises (8 exercises): Future Power Supply, 50% weight. Oral Exam (ca. 30 minutes) or Exercises (8 exercises): Smart Grid Management, 50% weight

Course type	Comment	SWS	Frequency	Workload attendance
Lecture		4.00	SuSe and WiSe	56 h
Seminar		4.00	SuSe and WiSe	56 h
<b>Total time of attendance for the module</b>				112 h

## pre151 - Renewable Energy in Developing Countries

<b>Module label</b>	Renewable Energy in Developing Countries			
<b>Module code</b>	pre151			
<b>Credit points</b>	12.0 KP			
<b>Workload</b>	360 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			1 Prüfungsleistung: Seminararbeit (40 S.) oder Referat (Präsentation - 45 Minuten, Ausarbeitung 20 Seiten) Im Seminar wird Aktive Teilnahme (siehe Ergänzung zu „§ 9 Abs. (6) ) gefordert.	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		4.00	SuSe and WiSe	56 h
Seminar		4.00	SuSe and WiSe	56 h
<b>Total time of attendance for the module</b>				112 h

## pre034 - Renewable Energy Technologies II

<b>Module label</b>	Renewable Energy Technologies II			
<b>Module code</b>	pre034			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Language of instruction</b>	English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	MM (Mastermodul / Master module)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			G	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Practical		2.00	SuSe or WiSe	28 h
<b>Total time of attendance for the module</b>				112 h



## pre091 - Transferrable skills

<b>Module label</b>	Transferrable skills			
<b>Module code</b>	pre091			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Language of instruction</b>	English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	MM (Mastermodul / Master module)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			G	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
Exercises		2.00	SuSe or WiSe	28 h
Practical		2.00	SuSe or WiSe	28 h
<b>Total time of attendance for the module</b>				112 h

## inf511 - Smart Grid Management

<b>Module label</b>	Smart Grid Management
<b>Module code</b>	inf511
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Business Informatics (Master) &gt; Akzentsetzungsmodulare der Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Angewandte Informatik</li> <li>• Master's Programme Engineering Physics (Master) &gt; Schwerpunkt: Renewable Energies</li> <li>• Master's Programme Environmental Modelling (Master) &gt; Mastermodule</li> <li>• Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>

### Contact person

Module responsibility

- Sebastian Lehnhoff
- Die im Modul Lehrenden

Authorized examiners

- Sebastian Lehnhoff
- Die im Modul Lehrenden

### Entry requirements

#### Skills to be acquired in this module

After successful completion of the course the students should be able to understand the existing structures and technical basis of energy systems to produce, transfer and distribute electricity and their interaction and dependency on each other. They should have developed an understanding for necessary IT- and process control technology components, methods and processes to control and operate electrical energy systems. The students are able to estimate and evaluate the requirements and challenges of ICT and computer science which are caused by the development and integration of unforeseeable fluctuations of decentralised plants. The students will be able to estimate the influence of distributed control concepts and algorithms for decentralised plants and consumers in the so called Smart Grid energy systems. Regarding the requirements the students will be able to analyse the safety, reliability, realtime capability and flexibility of Smart Grid energy systems.

#### Professional competence

The students:

- understand the existing structures and the technical basis of energy systems producing, transferring and distributing electricity and their interaction and dependency on each other.
- develop an understanding for necessary IT- and process control technology components, methods and processes to control and operate electrical energy systems.
- estimate and evaluate the requirements and challenges of ICT and computer science which are caused by the development and integration of unforeseeable fluctuations of decentralised plants.
- estimate the influence of distributed control concepts and algorithms for decentralised plants and consumers in the so called Smart Grid energy systems.

#### Methodological competence

The students:

- analyse the safety, reliability, realtime capability and flexibility of Smart Grid energy systems
- use advanced mathematical methods to calculate networks

#### Social competence

The students:

- create solutions in small teams
- discuss their solutions

#### Self-competence

The students:

- reflect their own use of electricity as a limited resource

### Module contents

Content of the Module: In this course information technology, economical energy industry and technical basic knowledge and methods are analysed by using concrete Smart Grid approaches. The basic calculation methods for an intelligent grid management are introduced.

This module deals with the technical and economical framework for a permissible electrical network as well as

mathematical modelling and calculation methods to analyse conditions of electrical energy networks (in stationary conditions).

These are:

- The organisation of the EU energy market (regulatory framework, responsibility in liberalisation of electrical energy systems)
- Establishment and operation of electrical energy supply networks (network topology, statutory duties of supply, supply quality/system services, malfunctions and protection systems)
- Network calculation (complex vector representation, effective/idle power, mathematical performance models/net model, transformation: node performance to node voltage and electricity, calculation of conductive current, current flow, fix-point-iteration, Newton-Raphson-Method, voltage drop, transformer model)
- Intelligent network management (Smart Grids), aggregation forms, machine learning approaches)

**Reader's advisory**

**Suggested reading:**

- Crastan V.: "Elektrische Energieversorgung II", Springer 2004
- Heuck K., Dettman K. D., Schulz D.: "Elektrische Energieversorgung I", 7. Aufl., Vieweg 2007
- Konstantin, P.: "Praxisbuch Energiewirtschaft", Springer 2006
- Schwab, A.: "Elektroenergiesysteme, Springer 2009

**Links**

<b>Language of instruction</b>	English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	jährlich			
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)			
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht			
<b>Lern-/Lehrform / Type of program</b>	V+Ü			
<b>Vorkenntnisse / Previous knowledge</b>				
Examination	Time of examination		Type of examination	
<b>Final exam of module</b>	At the end of the semester		Oral exam	
Course type	Comment	SWS	Frequency	Workload attendance
Lecture		3.00	SuSe	42 h
Exercises		1.00	SuSe	14 h
<b>Total time of attendance for the module</b>				56 h

## pre142 - Future Power Supply Systems

<b>Module label</b>	Future Power Supply Systems			
<b>Module code</b>	pre142			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	SPM (Schwerpunktmodul / Main emphasis)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			KL	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
<b>Total time of attendance for the module</b>				56 h

## pre152 - Resilience of RE Systems

<b>Module label</b>	Resilience of RE Systems			
<b>Module code</b>	pre152			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	SPM (Schwerpunktmodul / Main emphasis)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			G	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
<b>Total time of attendance for the module</b>				56 h

## pre153 - Mini-Grids

<b>Module label</b>	Mini-Grids			
<b>Module code</b>	pre153			
<b>Credit points</b>	6.0 KP			
<b>Workload</b>	180 h			
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Mastermodule</li> </ul>			
<b>Contact person</b>				
<b>Entry requirements</b>				
<b>Skills to be acquired in this module</b>				
<b>Module contents</b>				
<b>Reader's advisory</b>				
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>				
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	SPM (Schwerpunktmodul / Main emphasis)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>			G	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	SuSe or WiSe	28 h
Seminar		2.00	SuSe or WiSe	28 h
<b>Total time of attendance for the module</b>				56 h

## Abschlussmodul

### mam - Master's Thesis Module

<b>Module label</b>	Master's Thesis Module	
<b>Module code</b>	mam	
<b>Credit points</b>	30.0 KP	
<b>Workload</b>	900 h	
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>Master's Programme Postgraduate Programme Renewable Energy (Master) &gt; Abschlussmodul</li> </ul>	
<b>Contact person</b>		
<b>Entry requirements</b>		
<b>Skills to be acquired in this module</b>		
<b>Module contents</b>		
<b>Reader's advisory</b>		
<b>Links</b>		
<b>Languages of instruction</b>		
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>		
<b>Module capacity</b>	unlimited	
<b>Modullevel</b>	---	
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht	
<b>Lern-/Lehrform / Type of program</b>		
<b>Vorkenntnisse / Previous knowledge</b>		
<b>Examination</b>	Time of examination	Type of examination
<b>Final exam of module</b>		G
<b>Course type</b>	Seminar	
<b>SWS</b>		
<b>Frequency</b>		
<b>Workload attendance</b>	0 h	

