

## Master study course Renewable Energy Systems (M. Eng.)

<b>Module – No.</b>	<b>852</b>	<b>Mandatory module</b>	
<b>Module name</b>	<b>Photovoltaic Systems</b>		
Module coordinator	Sebastian Voswinckel, M. Eng.		
Title	Photovoltaic Systems		
Title of examination	Photovoltaic Systems		
Semester	1		
Course type	Lecture	English	
SWS/ ECTS/ Workload	4 V	5	150
Requirements for attendance	Successfully completed technical study course (e.g. Bachelor of Engineering)		

<b>1. Content and objectives</b>
<p><b>Content:</b> The students should achieve consolidated knowledge about installation, dimensioning and application of photovoltaic systems. In addition, the students get a profound introduction to the physics of solar cells.</p> <p><b>1. Introduction</b> History of photovoltaics - current trends and actors</p> <p><b>2. Basics</b> Introduction to semiconductor theory - generation and recombination processes - the solar cell as a p-n junction - modelling a real solar cell - thermodynamics of solar energy conversion</p> <p><b>3. Technology</b> Production process for silicon solar cells - production process for thin-film solar cells – measuring in photovoltaics</p> <p><b>4. System technology</b> From the single solar cell to a solar generator – control of solar generators - operation of grid-connected photovoltaic systems - operation of off-grid photovoltaic systems</p> <p><b>5. System design</b> Irradiation analysis - shading effects - mounting and interconnection - converters – grid connection – energy yield forecast - operation and maintenance of photovoltaic systems - economics</p> <p><b>Learning goals:</b> After successfully completing the module, the students have a deeper knowledge about solar cells as a semiconductor. They confidently deal with cell and module characteristics and use them, for example, to understand phenomena in interconnecting single modules to generators. Furthermore, the students are able to plan a photovoltaic system using standard design software and estimate the energy yield.</p>
<b>2. Method(s) of instruction</b>
The course takes the form of a lecture with integrated exercises and with the active involvement of the students. Exercises and case studies on the central topics of the lecture are presented, discussed and solved together. In addition, one practical laboratory experiment will be carried out in small groups.
<b>3. Requirements for attendance</b>
No course specific requirements
<b>Literature:</b>
[1] Merten: Photovoltaics: Fundamentals, Technology and Practice. John Wiley & Sons Inc, 2018. (introducing)
[2] Deutsche Gesellschaft für Sonnenenergie (DGS): Planning and Installing Photovoltaic Systems. A Guide for Installers, Architects and Engineers, 3rd Edition. (introducing)
[3] Wesselak/Voswinckel: Photovoltaik, Springer 2016 (introducing – only in german)
[4] Luque/Hegedus: Handbook of Photovoltaic Science and Engineering, Wiley, Chichester, 2011 (deepening)
[5] Würfel: Physics of Solar Cells, Wiley, Chichester, 2009 (deepening)
<b>4. Usability of this module</b>
The module is offered as mandatory module in the master study course „Renewable Energy Systems“ (M.Eng.)
<b>5. Requirements for assessment</b>

Assessment is performed either as written (duration 90 min) or oral examination. The prerequisite for the award of credit points is successful participation in the practical laboratory experiment (preliminary examination) and successful passing of the examination. The examination takes place during the examination period on the basis of the entire scope of material.

**6. ECTS credits**

5 ECTS credits

**7. Frequency of offer**

The module is lectured in the spring semester

**8. Work load**

The workload for this module is 150 h; this corresponds to 5 ECTS credits. This workload results from the attendance of lectures with active participation of the students (45 h) as well as the preparation and follow-up of the two laboratory experiments (15 h). Within the framework of self-study, the material covered in the lecture is to be reworked and discrete computer exercises should be carried out (about 75 hours). The preparation and execution of the examination is about 30 hours.

**9. Duration of module**

The module is lectured in one semester