MBB 7870 – Sustainable Energy Systems

1	**Module Number**	**Study Programme**	**Semester**	**Offered in**	**Duration**	**Module Type**	**Workload (h)**	**ECTS Points**
	7870	MBB	6	☒WS ☒SS	1 Semester	Comp. elective	240	8

2	**Courses**	**Teaching and Learning Forms**	**Contact Time**		**Self-Study Time**	**Language**
			(SWS)	**(h)**	**(h)**	
	a) Renewable Energy Sources and Carriers	Lecture	4	60	120	English
	b) Sustainable, Efficient and Decentralized Energy Systems	Lecture	2	30		
	c) Laboratory Sustainable Energy Systems	Lab	2	30		
				[1 SWS = 15h]		

3 **Learning Outcomes and Competences**

Once the module has been successfully completed, the students can...

Knowledge and Understanding

- … recognize the significance of renewable energy sources, i. e. solar energy, wind energy, hydro power, geothermal energy, bio-fuels and biomass and carriers.
- … recognize the significance of alternative, non-fossil fuels.
- … recognize the significance of sustainability, energy efficiency and its evaluation.
- … recognize the significance of energy consumption.
- … understand and explain the technical principles of the usage of renewable energy sources and of energy storage.
- … understand and explain the concept of exergy.
- … understand and explain the technical principles of energy conversion systems, like heat pumps.
- … understand the greenhouse effect.
- … understand Life Cycle Assessments (LCA).

Use, Application and Generation of Knowledge

Use and Transfer

- … apply the laws of thermodynamics and of fluid mechanics to evaluate the usage of renewable energy sources.
- … calculate the energy potential for the usage of renewable energy sources.
- … calculate energy losses in the framework of energy conversion systems.
- … calculate the exergy of thermodynamical systems.
- … analyze basically the energy efficiency of technical systems.
- … analyze the heat transfer of technical systems.
- … analyze the environmental impact of technical systems and its sustainability.
- ... take different perspectives and points of view on renewable energy sources and weigh them up against each other.
- ... take different perspectives and points of view on the energy supply of technical systems and weigh them up against each other.
- ... familiarize themselves with new ideas and topics in the framework of renewable energies and sustainability based on their acquired knowledge.

Scientific Innovation

- … optimize heat engines with respect to energy efficiency.
- … optimize the usage of renewable energy sources for electricity generation and for heating.
- ... independently develop approaches for usage of renewable energy sources and assess their suitability.
- ... independently develop approaches for the storage of energy and assess their suitability.
- ... independently develop approaches for efficient and sustainable energy systems and assess their suitability.
- ... develop concepts for the optimization of electricity generation by renewable energy sources.
- ... develop concepts for the optimization of energy storage.
- ... develop concepts for the optimization of the sustainability and the environmental impact of technical systems.

	Communication and Cooperation • ... communicate actively within an organization and obtain information about renewable energy sources and sustainability. • ... interpret the results of life cycle assessments and draw admissible conclusions. • ... use the acquired knowledge, to evaluate the usage of renewable energy sources and interpret them according to other aspects. • ... use the acquired knowledge, to evaluate the environmental impacts and the sustainability of technical systems and interpret them according to other aspects **Scientific Self-Conception/ Professionalism** • … derive recommendations for decisions from a sustainable perspective on the basis of the analyses and evaluations made. • ... justify solutions with respect to reliability, sustainability and efficiency theoretically and methodically.
4	**Contents** a) Lecture “Renewable Energy Sources and Carriers” (Lecturer: Stauch, Hartl) Fundamental overview of the description and calculation of renewable energy sources like solar energy, wind energy, hydro power, geothermal energy, bio-fuels and biomass. Overview on strategies and concepts for energy storage. Overview on alternative fuels and the generation and the use of hydrogen in fuel cells. b) Lecture “Sustainable, Efficient and Decentralized Energy Systems” (Lecturer: Stauch) Introduction to the concept of exergy. Calculation and evaluation of thermodynamical systems with respect to efficiency and sustainability. Evaluation of efficiency in the framework of electric power generation, heating and cooling. Overview on environmental impacts and sustainability metrics. Fundamentals of Life Cycle Assessments (LCA). c) Laboratory “Sustainable Energy Systems” (Instructor: Stauch, Czarnetzki) Using, deepening and enhancing the knowledge acquired in the lectures by performing experiments.
5	**Participation Requirements** Compulsory: • Thermodynamics 1 • Heat Transfer 1 Recommended: -
6	**Examination Forms and Prerequisites for Awarding ECTS Points** a) Written examination (120 minutes) (graded) b) Written examination (60 minutes) (graded) c) Laboratory: Certificate (It is also possible to grade the lab exercise if students need a grade.) The prerequisite for attending the laboratory exercises is the attendance of at least one of the lectures a) and b). The laboratory exercises take place on individual dates in small groups; dates are announced in the lecture.
7	**Further Use of Module** Compulsory elective subject within Bachelor program. Further use of module contents in: • MBB 7950 – Hybride Energiewandler • MBB 7850 - Strömungstechnik • RMM 3422 - Energieeffizienz • RMM AW1 - Energiewandlung, -speicherung und –systeme Bachelor thesis

8	**Module Manager and Full-Time Lecturer** a), b), c) Prof. Dr.-Ing. Rainer Stauch (Module Manager) a) Prof. Dr.-Ing. Sandra Hartl c) Prof. Dr.-Ing. Walter Czarnetzki
9	**Literature** • Scripts of lectures (including further references) • M. Kaltschmitt, W. Streicher, A. Wiese. Renewable Energy. Springer, 2007 • D.J.C. MacKay. Sustainable Energy – without the hot air. UIT, 2009 • J.W. Tester, E.M. Drake, M.J. Driscoll, M.W. Golay, W.A. Peters. Sustainable Energy – Choosing Among Options. MIT Press, Cambridge, 2005 • V. Wesselak, T. Schabbach, T. Link, J. Fischer. Handbuch Regenerative Energietechnik. 3rd edition, Springer, 2017
10	**Last Updated** 21.02.2024