## MBB 7870 – Sustainable Energy Systems

Module Number 7870	Study Programme MBB	Semester 6	Offered in ⊠WS ⊠SS	<b>Duration</b> 1 Semester	Module Type Comp. elective	Workload (h) 240	ECTS Points 8
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		Lecture		2	30		
c) Laboratory Sustainable Energy		Lab		2	30		
Systems					[1 SWS = 15h]		
Once the module has Knowledge and Una • recogni: energy, bi · recogni: • recogni: • recogni: • underst • apply th • calculat • calculat • analyze • analyze • take dif • optimize	as been successfull derstanding ze the significance o-fuels and biomas ze the significance ze the significance ze the significance and and explain the and explain the basically the green the heat transfer of the environmenta ferent perspective ferent perspective if the usage of reme the the usage of reme andently develop a p andently develop a p andently develop a p	y completed, the of renewable end ss and carriers. of alternative, in of sustainability of energy considered technical prime e concept of ex- ise effect. essments (LCA). <b>nowledge</b> Aynamics and of near the framework ermodynamical gy efficiency of of technical syst l impact of tech s and points of s and points of s and s and s and s and s and s and s and s and s and s and	energy sources, i non-fossil fuels. y, energy efficie umption. nciples of the use kergy. nciples of energy filuid mechanics ge of renewable of energy conve systems. technical systems a view on renewa view on the ener d topics in the fil ergy efficiency. sources for elect sage of renewable estorage of energy ficient and sust electricity gene energy storage.	e. solar energy ncy and its eval age of renewab conversion systems. conversion systems. ns. nd its sustainab ble energy source rramework of re tricity generation of energy source gy and assess ainable energy source ergy and assess ainable energy source	uation. le energy source tems, like heat p e usage of renew s. ility. rces and weigh t echnical systems newable energie m and for heatin res and assess th their suitability. systems and ass vable energy sou	es and of energy pumps, or comb wable energy so hem up against and weigh ther es and sustainab rg. heir suitability. ess their suitabi irces.	e storage. nined heat and urces. each other. n up against nility based on
	7870 Courses a) Renewable Energy Carriers b) Sustainable, Effice Decentralized Energy Carriers b) Sustainable, Effice Decentralized Energy c) Laboratory Sustai Systems Learning Outcomess Once the module have the module have Conce the module have Conce the module have Conce the module have Conce the module have an recognition of the module have an recognition of the module have an recognition of the module have an underst an underst an alyze an aly	7870       MBB         Courses       a) Renewable Energy Sources and Carriers         b) Sustainable, Efficient and Decentralized Energy Systems       c) Laboratory Sustainable Energy Systems         c) Laboratory Sustainable Energy Systems       c) Laboratory Sustainable Energy Systems         Learning Outcomes and Competence       Once the module has been successfull         Knowledge and Understanding       recognize the significance energy, bio-fuels and bioma.         recognize the significance       recognize the significance         recognize the significance       recognize the significance         recognize the significance       understand and explain th         understand and explain th       understand and explain th         understand the greenhous       understand the greenhous         understand and explain th       understand the greenhous         apply the laws of thermood       calculate the energy poter         calculate the energy poter       calculate the energy poter         analyze basically the energing       analyze the heat transfer         analyze the heat transfer       analyze the environmenta         take different perspective       take different perspective         take different perspective       take different perspective         .	Module Number 7870         Study Programme MBB         Semester 6           Courses         Teaching and Forms           a) Renewable Energy Sources and Carriers         Lecture           b) Sustainable, Efficient and Decentralized Energy Systems         Lecture           c) Laboratory Sustainable Energy Systems         Lab           Learning Outcomes and Competences         Date of the module has been successfully completed, the Knowledge and Understanding           .         recognize the significance of renewable energy, bio-fuels and biomass and carriers.           .         recognize the significance of alternative, recognize the significance of alternative, recognize the significance of energy cons           .         recognize the significance of energy cons           .         understand and explain the technical prir power (COP) systems.           .         understand the greenhouse effect.           .         calculate the energy potential for the usa           calculate the energy of thermodynamics and of calculate the energy of thermodynamical analyze basically the energy efficiency of analyze the heat transfer of technical sys analyze the heat transfer of technical sys analyze the environmental impact of tech take different perspectives and points of each other.           .         familiarize themselves with new ideas an their acquired knowledge.           Scientific Innovation         optimize heat engines with respec	Module Number 7870         Study Programme MBB         Semester 6         Offered in ⊠WS ⊠SS           Courses         Teaching and Learning Forms           a) Renewable Energy Sources and Carriers         Lecture           b) Sustainable, Efficient and Decentralized Energy Systems         Lecture           c) Laboratory Sustainable Energy Systems         Lecture           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 energy, bio-fuels and biomass and carriers.           • recognize the significance of alternative, non-fossil fuels.         • recognize the significance of energy consumption.           • understand and explain the technical principles of the usz         • understand and explain the technical principles of energy power (COP) systems.           • understand the greenhouse effect.         • understand the greenhouse effect.           • apply the laws of thermodynamics and of fluid mechanics         • calculate the energy potential for the usage of renewable           • calculate the energy of technical systems.         • analyze basically the energy efficiency of technical systems.           • analyze the environmental impact of technical systems.         • analyze the energy of technical systems.           • atke different perspectives and points of view on renewal         • t	Module Number 7870         Study Programme MBB         Gemester 6         Offered in ⊠WS ⊠SS         Duration 1 Semester           Courses         Teaching and Learning Forms         Cont           a) Renewable Energy Sources and Carriers         Teaching and Learning         Cont           b) Sustainable, Efficient and Decentralized Energy Systems         Lecture         4           c) Laboratory Sustainable Energy Systems         Lab         2           Learning Outcomes and Competences         Conte the module has been successfully completed, the students can         Knowledge and Understanding           •         recognize the significance of renewable energy sources, i. e. solar energy energy, bio-fuels and biomass and carriers.         recognize the significance of alternative, non-fossil fuels.           recognize the significance of energy consumption.         understand and explain the technical principles of the usage of renewab           understand and explain the technical principles of the usage of renewab         understand and explain the technical principles of energy conversion syster power (COP) systems.           understand and explain the technical principles of energy sources or syster power (COP) systems.         analyze the environmental infor the usage of renewable energy sources           analyze the energy potential for the usage of renewable energy source         calculate the energy optimal for the usage of renewable energy source           analyze the envi	Module Number 7870         Study Programme MBB         Semester 6         Offered in ⊠WS ⊠SS         Duration 1.Semester         Module Type Comp. elective Comp. elective           Courses         Teaching and Learning Forms         Contact Time           a) Renewable Energy Sources and Carriers         Lecture         4         60           b) Sustainable, Efficient and Decentralized Energy Systems         Lecture         2         30           c) Laboratory Sustainable Energy Systems         Lab         2         30           Learning Outcomes and Competences Once the module has been successfully completed, the students can         Knowledge and Understanding           •         recognize the significance of alternative, non-fossil fuels.         recognize the significance of sustainability, energy efficiency and its evaluation.           •         recognize the significance of sustainability, energy efficiency and its evaluation.         metrognize the significance of energy conversion systems, like heat power (COP) systems.           •         understand and explain the technical principles of the usage of renewable energy sources.         auderstand and explain the technical systems.           •         understand the greenhouse effect.         auderstand and explain the technical systems.           •         aclulate the energy tosses in the framework of energy conversion systems.           •         analyze the sait the	Module Number 7870         Study Programme MBB         Semester 6         Offered in 2WS ESS         Duration 1 Semester         Module Type Comp. elective         Workload (h) 240           Courses         Teaching and Learning Forms         Contact Time         Contact Time         Self-Study Time           a) Renewable Energy Sources and Carriers         Lecture         4         60         120           b) Sustainable, Efficient and Decentralized Energy Systems () Laboratory Sustainable Energy         Lecture         2         30         1           Learning Outcomes and Competences Once the module has been successfully completed, the students can         Knowledge and Understanding         (I SWS = 15h)         1           - recognize the significance of renewable energy sources, i. e. solar energy, wind energy, hydro power, ge energy, bio-fuels and biomass and carriers. - recognize the significance of sustainability, energy efficiency and its evaluation. - understand and explain the technical principles of the usage of renewable energy sources and of energy - understand and explain the technical principles of energy conversion systems, like heat pumps, or comb power (COP) systems. - understand the greenhouse effect. - understand the soft hermodynamics and of fluid mechanics to evaluate the usage of renewable energy sources. - analyze basically the energy efficiency of technical systems. - analyze basically the energy efficiency of technical systems. - analyze basically the energy efficiency of enerwable energy sources. - anal

	<ul> <li>Communication and Cooperation         <ul> <li> communicate actively within an organization and obtain information about renewable energy sources and sustainability.</li> <li> interpret the results of life cycle assessments and draw admissible conclusions.</li> <li> use the acquired knowledge, to evaluate the usage of renewable energy sources and interpret them according to other aspects.</li> <li> use the acquired knowledge, to evaluate the environmental impacts and the sustainability of technical systems and interpret them according to other aspects.</li> </ul> </li> <li>Scientific Self-Conception/ Professionalism         <ul> <li> derive recommendations for decisions from a sustainable perspective on the basis of the analyses and evaluations made.</li> <li> justify solutions with respect to reliability, sustainability and efficiency theoretically and methodically.</li> </ul> </li> </ul>
4	Contents
	<ul> <li>a) Lecture "Renewable Energy Sources and Carriers" (Lecturer: Stauch) 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.</li> <li>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</li> </ul>
	<ul> <li>environmental impacts and sustainability metrics. Fundamentals of Life Cycle Assessments (LCA).</li> <li>c) Laboratory "Sustainable Energy Systems" (Instructor: LB Schneider) Using, deepening and enhancing the knowledge acquired in the lectures by performing experiments.</li> </ul>
5	Participation Requirements
	Compulsory: <ul> <li>Thermodynamics 1</li> <li>Heat Transfer 1</li> </ul> Recommended:
6	Examination Forms and Prerequisites for Awarding ECTS Points
	<ul> <li>a) Written examination (120 minutes) (graded)</li> <li>b) written examination (60 minutes) (graded)</li> <li>c) Certificate</li> </ul>
7	Further Use of Module
	<ul> <li>Compulsory elective subject within Bachelor program.</li> <li>Further use of module contents in: <ul> <li>MBB 7950 – Hybride Energiewandler</li> <li>MBB 7850 - Strömungstechnik</li> <li>RMM 3422 - Energieeffizienz</li> <li>RMM AW1 - Energiewandlung, -speicherung und -systeme</li> </ul> </li> </ul>

8	Module Manager and Full-Time Lecturer						
	a), b) Prof. DrIng. Rainer Stauch (Module Manager) c) B.Eng. M.Eng Waldemar Schneider (Associate Lecturer)						
9	9 Literature						
	<ul> <li>Scripts of lectures (including further references)</li> <li>M. Kaltschmitt, W. Streicher, A. Wiese. Renewable Energy. Springer, 2007</li> <li>D.J.C. MacKay. Sustainable Energy – without the hot air. UIT, 2009</li> <li>J.W. Tester, E.M. Drake, M.J. Driscoll, M.W. Golay, W.A. Peters. Sustainable Energy – Choosing Among Options. MIT Press, Cambridge, 2005</li> <li>V. Wesselak, T. Schabbach, T. Link, J. Fischer. Handbuch Regenerative Energietechnik. 3rd edition, Springer, 2017</li> </ul>						
10	Last Updated 14.05.2019						