HS PF

MODULE HANDBOOK

COURSE OF STUDY FOCUS

BW/
RESOURCE EFFICIENCY-
MANAGEMENT
B.Sc.

Status: March 2020

TABLE OF CONTENTS

List of abbreviations

CR	Credits according to the ECTS system
PLH	Examination based on term paper
PLK	Examination based on written exam
PLL	Examination based on laboratory work
PLM	Examination based on oral exam
PLP	Examination based on project work
PLR	Examination based on presentation
PLS	Examination based on research project
PLT	Examination based on written thesis
PVL	Prerequisite examination
PVL-BVP	Prerequisite examination for bachelor interim overall exam
PVL-BP	Prerequisite examination for final bachelor graduation
PVL-MP	Prerequisite examination for final master graduation
PVL-PLT	Prerequisite examination for registration for bachelor thesis
SWS	Contact hours per week
UPL	Non-graded examination (pass/fail only)

Competence model - matrix of competence goals according to KMK Qualification framework for German university degrees
Study program modules BREM

Modules	Knowledge and understanding			Use, application and generation of knowledge		Connumication and Cooperation	Scientific Self-Image and Professionalism
	Knowledge broadening	Knowledge-deepening	Knowledge understanding	Use and transfer	Scientific innovation		
BREM1110	X	X					
BREM2210	X	X	X				
BREM2220	X		X				
BREM2230	X	X	X	X		X	
BREM2240	X	X	X	X		X	
BREM2250	X	X		X		X	X
LAW3200	X	X	X	X		X	X
BREM3000		X	X	X			X
BREM3110	/*	/*	/*	/*	/*	X	/*
BREM4000	X	X	X	X	X	X	X

*) depending on the chosen combination of the two elective subjects.

Second stage of study - modules specific to the course of study

BREM1110 -Technologies 1

Technologies 1	
Module ID	BREM1110
Semester	2
Credits	5
SWS	4
Frequency	in the summer semester
Associated courses	Production engineering (2 ECTS) Physics (3 ECTS)
Prerequisites	none
Assessment Methods and duration	PLK/PLM - 90 minutes
Requirements for granting of credits	Passing the examination performance
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 5
Planned group size	max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Mario Schmidt
Lecturer(s)	Prof. Dr. Mario Schmidt (Production Engineering) Prof. Dr. Claus Lang-Koetz (Physics) Prof. Dr. Tobias Viere (Physics)
Subject area / course of study	Resource efficiency management
Pedagogical Approach	Lecture with exercises
Applicability in other programs	none
Objectives	<u>Production engineering:</u> The students... • know the essential starting points for the careful use of energy and raw materials in production. • got to know a cross-section of different production companies and industries. • know the concept of resource efficiency and the most important publications on it. <u>Physics</u> The students... • Understand the physical basics of climate change • have an overview of the social and ecological consequences of climate change • Understand other important environmental problem areas, their natural science implications, and their societal implications.

	• know important climate and environmental protection measures
Content	Production engineering • Introduction to the topic of resource efficiency from the perspective of operational production • Examples and starting points for resource-saving production in the economy • Possibilities for saving energy and raw materials in production processes Physics: • Physical and scientific foundations of climate change • Social and environmental consequences of climate change • Causes and consequences of other environmental problem areas • Basics of climate and environmental protection
Relation to other modules	The module is the basis for all other course-specific modules in the degree program.
Workload	In addition to the 4 x 15 = 60 SWS attendance time, students are expected to spend an additional 90 h for preparation and post-processing, independent literature study, processing of exercise cases and exam preparation.
Literature	Production engineering: • Schmidt et al. (2017/2019): 100 companies for resource efficiency. Springer-Verlag Physics: • BMU, BMBF, and DE-IPCC UBA. "Fifth Assessment Report of the IPCC Subreport 1 (Scientific Basis)." (2015). • Heinrichs & Michelsen (eds.): Sustainability Science. Part III: Natural science perspectives. Springer-Verlag, 2014. • Steffen, Will, et al. "Planetary boundaries: Guiding human development on a changing planet." Science 347.6223 (2015). Latest edition in each case unless otherwise stated.
Additional Remarks	-
Keywords	Operational resource efficiency, environmental and climate protection
Last edited	August 2020

BREM2210 - Resources 1

Resources 1	
Module ID	BREM2210
Semester	3
Credits	6
SWS	4
Frequency	in the winter semester
Associated courses	Resource Efficiency and Industrial Ecology (3 ECTS) Raw materials and Resources (3 ECTS)
Prerequisites	none
Assessment Methods and duration	PLK - 90 minutes
Requirements for granting of credits	Passing the examination performance
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 6
Planned group size	max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Mario Schmidt
Lecturer(s)	Prof. Dr. Hendrik Lambrecht (Resource Efficiency and Industrial Ecology) Prof. Dr. Mario Schmidt (Raw Materials and Resources)
Subject area / course of study	Resource efficiency management
Pedagogical Approach	Lecture
Applicability in other programs	none
Objectives	<u>Resource Efficiency and Industrial Ecology</u> The students... • Can classify and critically reflect on the concept of resource efficiency in the context of sustainability and industrial ecology. • Know the historical, societal, and business significance of the environment and sustainability issues. • know the most important concepts and terms of the sustainability debate (strong vs. weak sustainability, efficiency, sufficiency and consistency strategy, etc.) • understand anthropogenic activities and economic activity as an energetic and material metabolism • Know the metastrategies of Industrial Ecology (circular economy, dematerialization, detoxification) and the central analytical paradigm of industrial metabolism. • Know the basic principles of material flow analysis as the most important tool of Industrial Ecology/material flow management. • have the prerequisite to understand advanced life cycle oriented analysis methods (especially LCA) in their mode of action

	Raw materials and resources The students... • Know the major commodity groups and raw materials that are important in production and are currently being discussed in the context of resource criticality (e.g., copper, aluminum, rare earths, gold, tantalum, phosphorus). • know the origin, the market situation, shortages and the importance for the addressed raw materials for future technologies, • know how selected such future technologies work and how they are applied in products, • learn concepts for evaluating the scarcity of raw materials such as criticality
Content	Resource Efficiency and Industrial Ecology • Introduction to Industrial Ecology (material flow analyses, input/output) • Eco and resource efficiency • Basics of sustainability • Introduction to Life Cycle Thinking methods Raw materials and resources • The lecture gives an overview of raw material groups and selected individual raw materials that are of great importance for production and are currently discussed in the context of resource criticality (e.g. copper, aluminum, rare earths, gold, tantalum, phosphorus). • To this end, concepts for evaluating scarcity are presented. • Corresponding applications in technologies or products are presented for the respective raw materials.
Relation to other modules	none
Workload	In addition to the 4 x 15 = 60 SWS attendance time, students are expected to spend an additional 90 h for preparation and post-processing, independent literature study, processing of exercise cases and exam preparation.
Literature	Resource Efficiency and Industrial Ecology • Heinrichs, H.; Michelsen, G. (Eds.) (2014) Sustainability science. Springer Spektrum, Berlin, Heidelberg • Graedel, Allenby (2010) Industrial Ecology and Sustainable Engineering. Pearson, Upper Saddle River • Ayres, Ayres (Hrsg.) (2002) A Handbook of Industrial Ecology. Edward Elgar, Northampton • Klöpffer, W., Grahl, B. (2009) Life cycle assessment (LCA). Wiley-VCH. Raw materials and resources • Achzet B., Reller A., Zepf V., University of Augsburg, Rennie C., BP, Ashfield M. and Simmons J., ON Communication (2011): Materials critical to the energy industry. An introduction • Angerer, G. et al. (2009): Rohstoffe für Zukunftstechnologien, Einfluss des branchspecific Rohstoffbedarfs in rohstoffintensiven Zukunftstechnologien auf die zukünftige Rohstoffnachfrage. BMWi/ ISI/ IZT • EU (2014): Report on critical Raw Materials for the EU. Report of the Ad hoc Working Group on defining critical raw materials
Additional Remarks	-

Keywords	Resource Efficiency, Industrial Ecology, Raw Materials, Resources
Last edited	August 2020

BREM2220 - Sustainability 1

Sustainability 1	
Module ID	BREM2220
Semester	3
Credits	6
SWS	4
Frequency	in the winter semester
Associated courses	Environment and Sustainability (3 credits) Production Technologies (3 credits)
Prerequisites	at least 35 credits achieved from the first stage of studies
Assessment Methods and duration	PLK/PLH/PLR - 90 minutes
Requirements for granting of credits	Passing the examination performance
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 6
Planned group size	max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Claus Lang-Koetz
Lecturer(s)	Prof. Dr. Claus Lang-Koetz (Environment and Sustainability and Production Processes) Prof. Dr. Hendrik Lambrecht (Environment and Sustainability) Prof. Dr. Nikolaus Thißen (Production Processes)
Subject area / course of study	Resource efficiency management
Applicability in other programs	none
Pedagogical Approach	Lecture
Objectives	<u>Environment and Sustainability</u> The students... • know the central scientific terms and laws, especially from the fields of mechanics, thermodynamics, electricity and inorganic chemistry. • are familiar with the concept of energy or conservation of energy and understand the main principles of conversion between different forms of energy. • know how matter is built up and know the basic principles of (chemical) material transformation. • can apply this knowledge to practical environmental and technical issues. <u>Production Technologies</u> The students... • Know the basic concepts and terms of manufacturing technology and manufacturing organization • know the most important properties of the materials iron and steel • can balance production processes in low complexity and

	create Sankey diagrams • are familiar with the most important manufacturing processes in the areas of forming, shaping and metal-cutting processes
Content	<u>Environment and Sustainability</u> • Introduction, basic tools of the trade • Mechanics • Thermodynamics • Electromagnetism • Structure of matter <u>Production Technologies</u> • Introduction and overview manufacturing technology • Basic principles of manufacturing organization • Properties of the materials iron and steel • Introduction to the balancing of production processes • Original molds from the liquid state (casting): casting production with lost mold and permanent mold. Casting defects and their prevention • Forming: Solid forming, sheet metal forming • Cutting processes: Cutting with geometrically definite and indefinite cutting edge, cutting by stock removal.
Relation to other modules	none
Workload	<u>Environment and Sustainability</u> • Harten, U.: Physics. An introduction for scientists and engineers. Springer, Heidelberg u.a. (E-book!) • Povh, B.: Anschauliche Physik für Naturwissenschaftler. Springer, Heidelberg. • Tipler, P. A.; G. Mosca: Physics for Scientists and Engineers. Spektrum, Heidelberg. <u>Production Technologies</u> • Ilschner, B.; Singer, R. F.: Materials Science and Manufacturing Engineering, Springer. • Witt, G.: Taschenbuch der Fertigungstechnik, Fachbuchverlag Leipzig. • König, W., Klocke, F.: Fertigungsverfahren 1-5: Urformtechnik, Gießen, Sintern, Rapid Prototyping: Bd 5; Springer. • Doege, E.; Behrens, B.-A.: Handbuch Umformtechnik, Springer. • Grote, K.-H.; Feldhusen, J.: Dubbel, Taschenbuch für den Maschinenbau; Springer.
Literature	In addition to the 4 x 15 = 60 SWS attendance time, students are expected to spend an additional 120 h for preparation and follow-up, independent literature study, processing of exercise cases and exam preparation.
Additional Remarks	-
Keywords	Environment, sustainability, production technology
Last edited	August 2020

BREM2230 - Technologies 2

Technologies 2	
Module ID	BREM2230
Semester	4
Credits	5
SWS	4
Frequency	in the summer semester
Associated courses	Environmental Technology (2 credits) Energy Technologies (3 credits)
Prerequisites	at least 35 credits achieved from the first stage of studies
Assessment Methods and duration	PLK/PLH + PLR- 180 minutes
Requirements for granting of credits	Passing the examination performance
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 5
Planned group size	max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Ingela Tietze
Lecturer(s)	Prof. Dr. Claus Lang-Koetz (Environmental Technologies) Prof. Dr. Nikolaus Thißen (Environmental Technologies) Prof. Dr. Ingela Tietze (Energy Technologies)
Subject area / course of study	Resource efficiency management
Applicability in other programs	none
Pedagogical Approach	Lecture with exercises
Objectives	<u>Environmental Technology</u> The students... • know selected basic operations (Unit Operations) of environmental engineering; • understand individual process combinations of basic operations in environmental engineering; • are familiar with the structures of environmental engineering systems and have mastered their basic design; • are familiar with theoretical and practical aspects of selected environmental techniques and are able to make practical reference to these techniques; • are able to build simple models for environmental issues and processes and to carry out corresponding simple balancing simulation calculations. <u>Energy Technologies</u> The students... • know the thermodynamic basics of energy conversion and the corresponding terminology, • know the relevant technical systems for energy conversion and supply, (both conventional (fossil) and renewable),

	• can independently perform basic calculations for the design and evaluation of energy conversion systems, • are able to compare energy conversion technologies from different points of view (technical, economical and ecological), • understand the connection between energy engineering and energy management aspects with regard to the different energy conversion technologies and • are familiar with concepts at the interface between energy technology and the energy industry, such as contracting and energy management.
Content	<u>Environmental Technology</u> • Introduction and overview environmental technology • Exhaust air treatment • Formation of gaseous emissions • Design and operation of selected processes for the treatment of exhaust gases • Simple modeling for balancing mass and energy flows for concepts to solve environmental engineering problems. • Presentation of resource-efficient concepts for the reduction and avoidance of emissions • Wastewater treatment • Waste water generation • Structure and mode of operation of individual selected processes for the treatment of wastewater • Treatment of special pollutants • Industrial wastewater treatment overview <u>Energy Technologies</u> • Thermodynamic basics • Steam generator and heat exchanger • Cold supply • Compressed air supply • Central technologies for electricity generation (steam power plants, gas and steam turbine power plants, • Use of renewable energies, combined heat and power generation)
Relation to other modules	None
Literature	<u>Environmental Technology</u> Textbooks: • K. Schwister et. al., Taschenbuch der Umwelttechnik, Fachbuchverlag Leipzig im Carl Hanser Verlag, 2003 • Hans Dieter Janke, Environmental Biotechnology, UTB GmbH, Stuttgart, 2008 • Wilhelm Hosang, Wolfgang Bischof, Wastewater Technology, B. G. Teubner, Stuttgart, Leipzig, 1998 • Heinz Brauer, Handbook of Environmental Protection and Environmental Engineering, Volume 3: Additive Environmental Protection: Treatment of Exhaust Air and Exhaust Gases, Springer, 1996. • Franz Joos, Technical Combustion, Springer, 2006 • Charles E. Baukal, Jr., The John Zink Combustion handbook, CRC Press, 2000 • Ulrich Förstner, Environmental Protection Technology, Springer, 2004 • Michael Schultes, Exhaust Gas Cleaning, Springer, 1996 • Michael F. Jischa, Studies in Environmental Science, Springer, 2004.

	• Stanley E. Manham, Environmental Science and Technology, Second Edition, Taylor & Francis Group, 2007 • H. D. Baehr, S. Kabelac, Thermodynamics, Fundamentals and Technical Applications, 15th edition, Springer, 2012. • M. Kraume, Transportvorgänge in der Verfahrenstechnik, Grundlagen und apparative Umsetzungen, 2nd edition, Springer, 2012. In-depth/substance data: • VDI Heat Atlas, Publisher: Association of German Engineers, VDI Society for Process and Chemical Engineering (GVC), 10th edition, Springer, 2006. • http://webbook.nist.gov/chemistry/ Energy Technologies • Richard Zahoransky: Power Engineering: Conventional and Renewable Energy Conversion Systems, Springer 2019.
Workload	In addition to the 4 x 15 = 60 SWS attendance time, students are expected to spend an additional 120 h for preparation and follow-up, independent literature study, processing of exercise cases and exam preparation.
Additional Remarks	-
Keywords	Power engineering, power generation, heat supply, refrigeration plants
Last edited	August 2020

BREM2240 - Resources 2

Resources 2	
Module ID	BREM2240
Semester	4
Credits	5
SWS	4
Frequency	in the summer semester
Associated courses	Industrial Energy Management (2 credits) Lean Production (3 credits)
Prerequisites	At least 47 credits achieved from the first stage of studies
Assessment Methods and duration	PLK/PLH/PLR - 90 minutes
Requirements for granting of credits	Passing the examination performance
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 5
Planned group size	max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Frank Bertagnolli
Lecturer(s)	Prof. Dr. Ingela Tietze (Industrial Energy Management) Prof. Dr. Frank Bertagnolli (Lean Production)
Subject area / course of study	Resource efficiency management
Applicability in other programs	none
Pedagogical Approach	Lecture with exercises
Objectives	<u>Industrial Energy Management</u> The students... • know the concept of energy management systems according to DIN EN ISO 50.001 and can explain strengths and weaknesses • can classify the operational energy demand by determining relevant key figures • are able to identify typical energy saving potentials and develop solutions for them • are familiar with common approaches to operational energy self-sufficiency and can evaluate them economically and technically • know the central energy markets and their pricing mechanisms • Understand energy procurement requirements and be able to develop and evaluate appropriate procurement models based on demand characteristics.

	Lean Production The students... • know the history, approaches and interrelationships of the Toyota Production System as well as other holistic production systems, • know essential analysis methods (value stream mapping) and principles from the field of lean production and can apply them to simple cases in practice, • know the effect of Lean Production on the productivity of a company as well as the goals that derive from it for managers, • were confronted with corresponding management approaches.
Content	Industrial Energy Management • Introduction (basic terms, load curves, energy management and its components). • Energy management according to DIN EN ISO 50001 • Operational demand and energy savings • Technical and economic evaluation of power supply plants (conventional, CHP, renewable energies) • German electricity and natural gas market • Electricity and gas procurement (full supply contracts, portfolio management) Lean Production • Introduction • Waste • Flow, beat, pull • Value stream mapping • Perfection • Standardization • Continuous improvement • Supply Logistics • Production area assembly • Production area manufacturing • Lean and production systems
Relation to other modules	none
Literature	Industrial Energy Management • Panos, K.: Praxisbuch Energiewirtschaft, Energieumwandlung, -transport und -beschaffung im liberalisierten Markt, Springer, 2013. • DIN EN ISO 50.001 Energy management systems - Requirements with guidance for use (ISO 50001:2011) • Geilhausen, M.; Bränzel, J.; Engelmann, E.; Schulze, O.: Energiemanagement: Für Fachkräfte, Beauftragte und Manager, Springer, 2015. Lean Production • Bertagnolli, F.: Lean Management. Springer Gabler • Ohno, T.: The Toyota Production System. Campus • Womack, J.P., Jones, D.T.: Lean Thinking: Drop Ballast, Increase Company Profits. Campus • Rother, M., Shook, J.: Learning to see: increasing value and eliminating waste with value stream design. Lean Management Institute • Takeda, H.: The Synchronous Production System. Vahlen

Workload	In addition to the 4 x 15 = 60 SWS attendance time, students are expected to spend an additional 90 h for preparation and follow-up, independent literature study, processing of exercise cases and exam preparation.
Additional Remarks	-
Keywords	Energy Management, Energy Saving, Lean Production, Lean Management
Last edited	August 2020

BREM2250 - Sustainability 2

Sustainability 2	
Module ID	BREM2250
Semester	4
Credits	9
SWS	6
Frequency	in the summer semester
Associated courses	LCA and Material Flow Assessments (3 credits) CMM in Resource Efficiency Management (3 credits) CSR and Sustainability Management (3 credits)
Prerequisites	At least 47 credits achieved from the first stage of studies
Assessment Methods and duration	PLL/PLH/PLR BREM2252 PLK (90 minutes)
Requirements for granting of credits	Passing of the respective examination performances
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 9
Planned group size	max. 50 students
Language	German and English (CSR and sustainability management)
Module Duration	1 semester
Module Coordinator	Prof. Dr. Hendrik Lambrecht
Lecturer(s)	Prof. Dr. Hendrik Lambrecht (LCA and Material Flow Assessments as well as CMM in Resource Efficiency Management) Prof. Dr. Tobias Viere (CMM in Resource Efficiency Management as well as CSR and Sustainability Management)
Subject area / course of study	Resource efficiency management
Applicability in other programs	none
Pedagogical Approach	Lectures, exercises, laboratory
Objectives	<u>LCA and Material Flow Assessments</u> The students... • have deepened their knowledge of a selected analysis method (LCA, material flow costing, energy and material flow analysis) by applying it to given or self-selected problems • learn to document or communicate their own research results according to scientific standards (reproducible, comprehensible). <u>CMM in Resource Efficiency Management</u> The students... • know important software tools for problem solving in the field of resource efficiency management and their fields of application • can use the tools independently for simple tasks and questions

	<u>CSR and Sustainability Management</u> The students... • understand the business context of environmental and sustainability issues, in particular corporate social responsibility and sustainability management and their theoretical foundation • know important concepts and tools in this field, especially environmental management systems, material flow cost accounting and sustainability communication

Content	<u>LCA and Material Flow Assessments</u>
	New seminar topics assigned each semester in the areas of.
	• LCA
	• Energy and material flow analyses (both at macroeconomic and operational level)
	• Material Flow Cost Accounting
	
	<u>CMM in Resource Efficiency Management</u>
	• The focus here is on IT deployment.
	• To deepen the knowledge from the other two courses of the module and to link it to the topic area of Lean, practice-oriented tasks are solved with the support of common software.
	• In particular, Excel, Visio, e!Sankey and Umberto are used.
	
	<u>CSR and Sustainability Management</u>
	• Reasons for companies to address environmental and sustainability issues
	• References to stakeholder theory and business ethics
	• Historical development of CSR and sustainability management
	• Important tools and concepts
	  o Environmental management systems
	  o Environmental accounting incl. material flow cost accounting
	  o Sustainability reporting and communication
	  o Sustainable Entrepreneurship
	  o More methods

Relation to other modules	none
Literature	<u>LCA and Material Flow Assessments</u> • Depending on the topic: will be announced in the course <u>CMM in Resource Efficiency Management</u> • The course will provide relevant tutorials for software applications <u>CSR and Sustainability Management</u> • Sanders, N. R., & Wood, J. D. (2019). Foundations of sustainable business: Theory, function, and strategy. John Wiley & Sons • ISO 14001: Environmental Management Systems • ISO 14051: Material Flow Cost Accounting • IFAC (2004): International Guidelines on Environmental Management Accounting (EMA) • Schneider, A., & Schmidpeter, R. (2012). Corporate social responsibility. Springer Berlin Heidelberg

Workload	In addition to the 6 x 15 = 90 SWS attendance time, students are expected to spend an additional 180 h for preparation and follow-up, independent literature study, processing of exercise cases and exam preparation.
Additional Remarks	The work on the PC is possible in groups of max. 2 persons. In any case, individual work on the PC should also take place in the module in order to ensure that all participants acquire modeling and IT competence. CSR and Sustainability Management is offered exclusively in English as part of the International Study Program. The credits earned will count toward the 24-credit requirement of the program. This course is usually offered as a fast track with an increased number of hours per week and an early exam well before the normal exam period.
Keywords	CSR, LCA
Last edited	August 2020

LAW3200 - Legal Aspects of Environmental Protection

Legal Aspects of Environmental Protection	
Module ID	LAW3200
Semester	6
Credits	5
SWS	4
Frequency	every semester
Associated courses	Legal Aspects of Environmental Protection
Prerequisites	At least 47 credits achieved from the first stage of studies
Assessment Methods and duration	PLM/PLH/PLK (60 minutes)
Requirements for granting of credits	Passing the examination performance
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 5
Planned group size	max. 50 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Tobias Brönneke
Lecturer(s)	Prof. Dr. Tobias Brönneke Dr. Rüdiger Herpich
Subject area / course of study	Law / Resource Efficiency Management
Applicability in other programs	none
Pedagogical Approach	Lecture with exercises
Objectives	The students... • recognize legal issues at the interface with business and technical resource efficiency management • have a first overview of the most important German and European environmental regulations • can distinguish between what the law requires of a citizen/company (substantive requirements) and the instruments it provides for implementing these requirements and with which the authorities ensure compliance with the law. • are familiar with practical aspects of environmental protection and resource conservation • are able to discuss legal problems in the context of resource efficiency management with environmental law specialists or lawyers in a solution-oriented manner and to participate adequately in the appropriate resolution of the issues. <u>Critical thinking and analytical skills</u> Students will be able to apply analytical skills constructively and-critically to problems. <u>Communication skills</u> Students will be able to express complex issues in clear written form.

Content	• Environmental law: introduction, goals, principles and systematics, legal sources of environmental law • Instruments of environmental administration: plant permits, ancillary provisions and orders, operating prohibitions, discretionary powers • Legal protection in environmental law • Immission control law • Circular economy and waste law • Operational framework for the implementation of resource efficiency • Material flow management in the context of resource efficiency: REACH, GHS/CLP, hazardous goods law, ProdHaftG, KrWG • Production and handling of hazardous substances / products • Implementation of resource efficiency and sustainability regulations • Global industry standards, norms and management systems on quality / environmental protection / energy: ISO9001, 14001, 50001 (EMAS) and their relation to state, European and international law • Resource efficiency in practice: industrial promotion, examples of implementation
Relation to other modules	The module builds on LAW1010 (Law I), LAW1200 (Law II)
Literature	• Nomos: Public law (legal texts) • supplementary printed legal texts as necessary working material • Erbguth/Schlacke: Environmental Law, latest edition • Oberrath: Public law or • Detterbeck: Public Law. - latest edition - Scripts of the two partial courses can be found on the E -Learning platform
Workload	In addition to the 4 x 15 = 60 SWS attendance time, students are expected to spend an additional 90 h for preparation and follow-up, independent literature study, processing of exercise cases and exam preparation.
Additional Remarks	The module may also be taken as part of an equivalent performance during a semester of study abroad.
Keywords	Environmental law
Last edited	August 2017

BREM3000 - Markets and the Economics of Natural Resources

Markets and the Economics of Natural Resources	
Module ID	BREM3000
Semester	6
Credits	5
SWS	4
Frequency	every semester
Associated courses	Markets and the Economics of Natural Resources
Prerequisites	At least 47 credits achieved from the first stage of studies
Assessment Methods and duration	PLK - 90 minutes
Requirements for granting of credits	Passing the examination performance
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 5
Planned group size	max. 50 students
Language	English
Module Duration	1 semester
Module Coordinator	Prof. Dr. Jürgen Antony
Lecturer(s)	Prof. Dr. Jürgen Antony
Subject area / course of study	Economics
Applicability in other programs	none
Pedagogical Approach	Lecture with exercises
Objectives	The students... • know the most important commodity markets (including secondary raw materials and energy) and how they function, • are able to track and estimate commodity prices on the world markets, • Know the basic principles of resource economics • are familiar with resource policy options (operational, macroeconomic).
Content	<u>Commodity markets</u> • Operation of LMX, EEX, CME, MCX, etc. • Price developments and influencing factors within the raw materials and energy industry • Shifting effects (e.g. BTL) • Forecasts • Public goods, Tragedy of the Commons, externalities, resource allocation, Coase theorem, Pigou taxes, Hotelling Rule, Hartwick Rule, Jevons and rebound effects, UGR. <u>Raw materials policy</u> • Operational risk management • Political options for action and actors
Relation to other modules	none

Literature	• Baker, R. P. (2010): The Trade Lifecycle: Behind the Scenes of the Trading Process (Wiley Finance) • Clark, E. et al. (2001): International Commodity Trading: Physical and Derivative Markets (Wiley Trade Series) • Conrad, J. (2011): Resource Economics. Cambridge University Press • OECD (2012): Sustainable Materials Management: Making Better Use of Resources, Paris • Perman, R. et al. (2011): Natural Resource and Environmental Economics, Pearson
Workload	4 x 15 SWS = 60 SWS attendance time plus 90 h for preparation and post-processing, independent study of literature, processing of case studies and exercises and exam preparation
Additional Remarks	The module may also be taken as part of an equivalent performance during a semester of study abroad. The module is offered exclusively in English as part of the International Study Program. Credits earned will count toward the 18-credit requirement in the program.
Keywords	Resource Economics, Resource Markets, Scarcity, Risk Management, Resource Policy, Sustainable Development, Non-renewable Resources
Last edited	August 2020

BREM3110 - Electives: Practical Applications in Efficiency

Electives: Practical Applications in Efficiency	
Module ID	BREM3110
Semester	6
Credits	6
SWS	4
Frequency	every semester
Associated courses	• Methods of Quality Management (3 Credits) • Technology and Innovation Management (3 credits) • Seminar Lean Management (3 credits) • Industrial Change Management (3 credits) • Renewable Energies (3 credits) • Interdisciplinary Studies (3 credits) Alternative offerings or enrollment in WPF from other degree programs possible.
Prerequisites	At least 47 credits achieved from the first stage of studies
Assessment Methods and duration	PLP / PLR / PLH / PLK (60 minutes)
Requirements for granting of credits	Passing of the respective examination performances. WPF offerings totaling 6 credits must be successfully completed.
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 6
Planned group size	max. 30 students
Language	German / English
Module Duration	1 semester
Module Coordinator	Prof. Dr. Frank Bertagnolli
Lecturer(s)	Lecturer (Methods of Quality Management) Prof. Dr. Claus Lang-Koetz (Technology and Innovation Management) Prof. Dr. Frank Bertagnolli (Seminar Lean Management as well as Industrial Change Management) Prof. Dr. Ingela Tietze (Renewable Energies) Various lecturers (interdisciplinary studies)
Subject area / course of study	Resource efficiency management
Applicability in other programs	Individual WPF offerings can also be taken by other degree programs
Pedagogical Approach	Lecture with exercises / seminar / project

Objectives	The WPF module is designed to provide students with the opportunity for an individualized, course-specific focus. The objectives differ depending on the WPF offered: Methods of Quality Management Students have basic knowledge of relevant quality management methods, know the basics of quality management systems with the relevant ISO standards and know how to apply central analysis tools to simple problems. Technology and Innovation Management Students learn the basics of technology and innovation management and their importance for companies. They learn how to apply selected methods using simple problems from practice. Seminar Lean Management Students are able to independently research, develop and present a complex, practice-relevant topic. They can process literature and systematize and incorporate practical experience. They are familiar with the basics and also with some details from the field of lean management and recognize the transfer in practice. Industrial Change Management The students know why changes take place, are necessary and are something normal. They know the course of a change and its side effects as well as backgrounds and can classify the topic of change management in the context of their studies and future field of work. The students know the most important starting points and obstacles within change management. They know leadership tools and methods for successful planning and internal implementation of change. In addition, they reflect on themselves in the context of change and further develop their personality. Renewable Energies The students learn the economic and technical basics of the use of renewable energies. They are able to evaluate sites with regard to the use of different technologies. Location-dependent rough concepts can be developed and evaluated technically, economically and ecologically. Interdisciplinary Studies The students are able to carry out an interdisciplinary project on a challenging topic independently and in a team, which requires social interaction as well as methodological demands. The focus is not only on instrumental competence but also on systemic competence.
Content	The contents of the events are based on the common topics of the respective subjects and are always intended to convey instruments in addition to the basics and to demonstrate their use with practical examples.
Relation to other modules	Elective subjects in cluster with other subjects of business administration
Literature	Methods of Quality Management • Sower, Victor (2001): Essentials of Quality, Wiley • Seghezzi, H.D.; Fahrni, F.; Friedli, T. (2013): Integriertes Qualitätsmanagement, Hanser.

	Technology and Innovation Management • Vahs, D.; Brem, A. (2013): Innovationsmanagement - Von der Idee zur erfolgreichen Vermarktung, 4th edition, Schäffer-Poeschel Verlag. • Spath, D. et al: Technologiemanagement. Grundlagen, Konzepte, Methoden, Fraunhofer Verlag. Seminar Lean Management • Bertagnolli (2018) Lean Management. Springer Gabler. Industrial Change Management • Bertagnolli et al. (2018) Change Canvas. Springer Gabler. • Kruse (2004) next practice. Successful management of instability. Gabal. • Regber and Zimmermann (2001): Change Management in Production: Improving Processes Efficiently in a Team. Modern Industry. • John P. Kotter (2011): Leading Change (German edition). Vahlen. • Doppler et al. (2011): Corporate change against resistance: change management with people. Campus. • Lauer (2010): ChangeManagement: Fundamentals and Success Factors. Springer. Renewable Energies • Kaltschmitt, Martin, Streicher, Wolfgang, Wiese, Andreas (2020): Renewable Energies. Springer • Quaschning, Volker (2020): Renewable Energies and Climate Protection. Carl Hanser
Workload	2 x 15 SWS = 30 SWS attendance time, plus 60 hours each for preparation and follow-up, independent literature study, processing of case studies and exercises, and exam preparation.
Additional Remarks	The module or an individual course of the module can also be completed as part of a semester abroad. Modules or events related to the main focus of the study program are eligible for recognition. English language courses within the module are offered as part of the International Study Program (ISP). The credits earned will count towards the 18-credit requirement in the program. The elective courses, especially if they are offered in English by visiting professors, can be organized as fast-track courses with an examination well before the normal examination period.
Keywords	Interdisciplinarity
Last edited	August 2020

BREM4000 - Seminar Resource Efficiency Management

Seminar Resource Efficiency Management	
Module ID	BREM4000
Semester	7
Credits	8
SWS	2
Frequency	every semester
Associated courses	Seminar Resource Efficiency Management
Prerequisites	At least 47 credits achieved from the first stage of studies
Assessment Methods and duration	PLH/PLR/PLP
Requirements for granting of credits	Passing the examination performance
Significance for the Final Grade	The module is weighted with its credits in the Bachelor final grade. Weighting according to credits = 8
Planned group size	max.30 students
Language	German
Module Duration	1 semester
Module Coordinator	Prof. Dr. Claus Lang-Koetz
Lecturer(s)	Prof. Dr. Claus Lang-Koetz
Subject area / course of study	Resource efficiency management
Applicability in other programs	none
Pedagogical Approach	Seminar
Objectives	The students... • are able to independently develop and present a complex technical-business topic on resource efficiency, • can review scientific literature and/or systematize and incorporate (possibly indirect) practical experience, • are familiar with the basics and also with some details from the field of production organization and resource efficiency management, • can independently conduct analysis in the context of resource efficiency management and derive conclusions, • have all the requirements for the preparation of a thesis work. The module thus primarily serves to deepen knowledge and to acquire instrumental, systemic and communicative competence.
Content	In the REM seminar, a technical-business topic on resource efficiency is worked on independently by the students under the guidance of the lecturer. The students conduct a technical research and analyze and work independently on a given topic from science and / or practice ("research and practice topic").
Relation to other modules	none

Literature	Depending on the respective topics and contents
Workload	2 x 15 SWS = 30 SWS attendance hours plus 210 h preparation and wrap-up time including literature study as well as for the processing and presentation of a case study or a presentation.
Additional Remarks	The module is offered in the 7th semester blocked within the first 6 or 7 weeks of lectures.
Keywords	Seminar, Resource Efficiency Management
Last edited	August 2020