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SPEEC – INTERNATIONAL SEMESTER PROGRAM IN ENERGY ECONOMICS

Technische Hochschule Ulm
University of Applied Sciences

SPEEC - Semester Program in Energy Economics

International Semester Exchange Program

2023/2024

Contents

Important Dates

Academic Calendar	
Fall semester:	**Spring semester:**
Classes start: Beginning of October	Classes start: Beginning of March
Holidays: 2 weeks in Dec/Jan (Christmas)	Holidays: 2 weeks in May/June (Pentecost)
Exams: 2 weeks in Jan/Feb	Exams: 2 weeks in July

Orientation days	
Fall semester:	**Spring semester:**
Arrival: September 4th, 2023 or October 4th, 2023	Arrival: 1st working day of March
Orientation: Beginning of September / Beginning of October	Orientation: Beginning of March
Preparatory German intensive course:	**Preparatory German intensive course:**
1 or 2 weeks in September (depending on previous knowledge)	1 or 2 weeks in March (depending on previous knowledge)

Exams

In case a student fails a course, i.e. is awarded a grade of 4.7 or worse, a re-examination may be done within 2 weeks after the announcement of the exam results. The examiner decides both the date and the form of the re-examination.

For conducting the re-examination the candidate has to be present in person. The exam may not be taken at the home university.

Coordination

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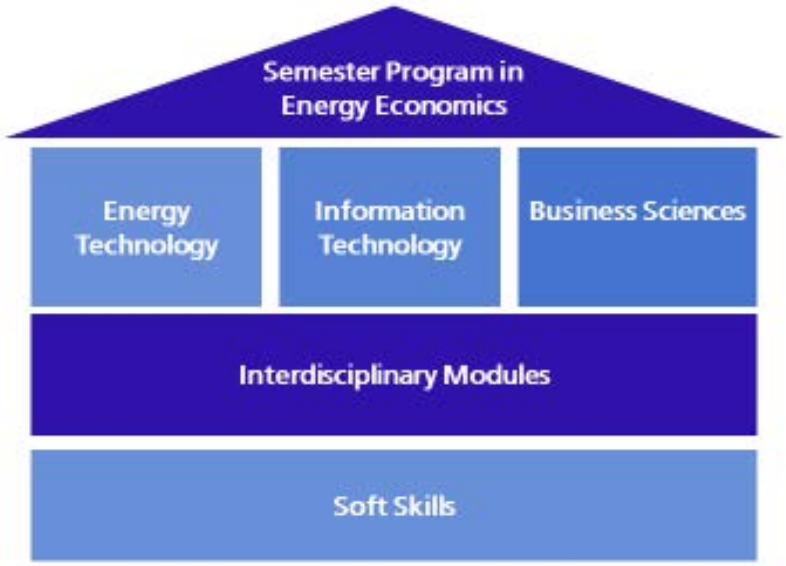
International Semester Program in Energy Economics (SPEEC)

The program:

The International Semester Program in Energy Economics is offered by the Technische Hochschule Ulm (Ulm University of Applied Sciences) to international students.
The program runs for the regular semester time in spring (March-July) and autumn (end of September-February) and is taught in English, in classes together with German students.
A variety of different courses in energy economics which combine the fields of **Energy Technology, Computer Science, and Business Economics** are offered. The lectures are accredited, allowing the students to transfer credits back home.



The following lectures are possible

SPEEC Courses	Credits (ECTS)	
	Fall semester	Spring Semester
Leadership and Business Communication	5	5
Sustainability and the Environment	5	5
System Automation	4	4
Cross-Cultural Management	5	5
Elements of Complex Systems Simulation	5	5
Energy Project	5	5
German as a foreign language (depending on the level)	2,3 or 5	2, 3 or 5
Analytics for Energy Data	5	
Energy Efficiency	5	
Statistics	5	
Project Management	5	
Energy Regulation	5	
Energy Meteorology	5	
Germany within Europe	4	

SPEEC Courses	Credits (ECTS)	
	Fall semester	Spring Semester
Operations Research		5
Energy Trading and Risk Management		5
Data Management in Energy Markets		5
Seminar in Energy Economics		5
Performance Management		5
Germany in the last three centuries		4
Energy Storage		5

Remarks:

Please note, that the courses "Seminar in Energy Economics" and "Energy Project" are limited concerning the number of participants.

Some courses might overlap – schedules change each semester.
English taught facultative modules in the field of energy economics will take place every semester as well. But they vary from semester to semester.

Language Courses:

Ulm University of Applied Sciences is offering an intensive German language course for students with no or little knowledge of German. The course takes place before the start of the program and runs two weeks. Students with previous knowledge of German can take part in an introductory one-week block course to refresh their German and learn about aspects of culture and daily life. The program is also accompanied by parallel German language classes for different levels during the semester.

Leadership and Business Communication

Semester	Fall and Spring semester
Work load	45 minutes x 4 per week 150 h
Credit points	5 ECTS-Credits
Prerequisites	None
Learning objectives	Managers are required to successfully lead (international) teams, understand organizational contexts and change as well as achieve goals through professional internal communication regardless of their own technical background. This seminar imparts the knowledge and competencies necessary to deal with organizational behavior, leadership and corporate communication and well as intercultural aspects of management. Furthermore, participants will prepare CEO / consultant presentations and develop their communication skills in this method.
Content	**Topics** Introduction to the course and the technique of CEO presentations. Leadership in organizations Organizational structures and their impact on communication Corporate culture and interculture Intercultural leadership competence Diversity management Decision making and micro-politics in organizations Corporate communication Negotiation Business ethics and CSR Public Affairs and crisis communication
Mode of evaluation	Exam (90 minutes) plus group presentation or essay

Sustainability and the Environment

Semester	Fall semester and Spring semester
Amount of weekly sessions	4 sessions of 45 minutes each
Total work load	150 h
Credit points	5 ECTS
Prerequisites	Basic accounting skills or additional home study required
Learning objectives	• A deeper understanding of environmental policy. • Improved verbal and written presentation skills in English. • an abilty to see their technical subject and its consequences through the perspective of social science. • an ability to understand a wide range of demanding, longer texts, and recognise implicit meaning. • an ability to express themselves fluently and spontaneously without much obvious searching for expressions. • an ability to use the English language flexibly and effectively for social, academic and professional purposes. • an ability to produce clear, well-structured, detailed text on complex subjects, showing controlled use of organisational patterns, connectors and cohesive devices. • greater ability and confidence to discuss in English and to take part in teamwork and meetings. • greater abilty to use English in oral presentations and in preparing written reports.
Content	• A global perspective: colonisation and industrialisation; globalisation, global warming and bio-diversity. • Design of environmental policy: environment as an economic and social asset; voluntary, command and control, and incentive based programs; pressure groups. • Environmental policies in industrialised countries. • Developing countries, poverty and the environment. International environmental protection.
Mode of evaluation	Exam

System Automation

<table>
<tr><td>Semester</td><td>Fall Semester</td></tr>
<tr><td>Prerequisites</td><td>Dynamic Systems I</td></tr>
<tr><td>Textbook</td><td>Prof. Dr. Walter Commerell
System Automation</td></tr>
<tr><td>References</td><td>Levine: The Control Handbook, IEEE Press, 1996
Katsuhiko Ogata: Modern Control Engineering, Prentice Hall, 1997</td></tr>
<tr><td>Credit points</td><td>4 ECTS-Credits</td></tr>
<tr><td>Course Learning Objectives</td><td>The objective of the lecture is to give an overview on different system with their behavior and to provide an understanding of the system. The students gain the knowledge how to describe the behavior of the system and design a model of the system on the computer. To model the system the same software as in the lecture “Dynamic Systems” will be used.

The students learn how to structure and analyze the system and design the required automation solution. The students learn how to control event systems and continuous systems. Therefore, the overall design process and the design steps are discussed and realized on practical examples

Upon completion of this course the student will be able to:
1. Structure a multi domain system. Examples from automotive industry and common process industry will be used.
2. Analyze multi domain systems with continuous and discrete parts as well as hybrid systems with both parts.
3. Understand and work on base of a model based design process using an accepted professional simulation tools, such as Matlab/Simulink.
4. Design a concept on base or the user requirements
5. Design automation solutions on base of standard automation components as PLC or continuous controller</td></tr>
<tr><td>Content</td><td>Topics covered:
<table>
<tr><th>Week</th><th>Topics</th></tr>
<tr><td>1</td><td>Introduction to System Automation</td></tr>
<tr><td>2</td><td>Description of different Systems</td></tr>
<tr><td>3</td><td>View on continuous Systems</td></tr>
<tr><td>4</td><td>View on discrete Systems</td></tr>
<tr><td>5</td><td>Analysis of Systems</td></tr>
<tr><td>6</td><td>Structure of Systems</td></tr>
<tr><td>7</td><td>Automation Process</td></tr>
<tr><td>8</td><td>Requirements Process</td></tr>
<tr><td>9</td><td>Design of Automation Solutions</td></tr>
<tr><td>10</td><td>Examples</td></tr>
<tr><td>11</td><td>Examples</td></tr>
</table></td></tr>
</table>

Schedule	Four weekly lecture sessions of 45 minutes each One weekly lab session of 90 minutes
Computer Usage	You'll gain knowledge in PLC Programming and Controller design using MatLab/Simulink
Mode of Evaluation	Attendance and written lab reports required 1 written test
Distribution	Written mid-term test 50%, written final test 50%

Cross-Cultural Management

Amount of weekly sessions	4 sessions of 45 minutes each
Semester	Fall semester and Spring semester
Total work load	150 h
Credit points	5 ECTS-Credits
Prerequisites	Interest in Economics, Business Administration and Intercultural Communication
Learning objectives	Understand the cultural background and behavior of international business partners, their goals and motivations, develop constructive relationships in the international workplace, deal effectively with partners from all over the world and develop awareness of the dynamics in globalization and international business. Deal with situations in the international business context and develop solutions for business cases.
Content	Core intercultural theories regarding business and management The impact of globalization on organizational cultures Process and strategies of internationalization Business case studies + students' presentations
Mode of evaluation	Exam (90 minutes)

Energy Project

Course of Study	International Energy Economics
Semester	Fall semester and Spring semester
Identification of Module	Project in Energy Economics
Semester	5
Academic form / SWS	Project
Work load	300h
Credit points	5 ECTS-Credits
Educational objective / Competency	The student acquires the ability to work on a larger problem in energy economics in a small team, applying and training methods and techniques developed in courses.
Content	• In the first week of the semester (start of the lectures) the students can choose out of a set of different project topics • In the last week of the exams (2 weeks after the end of the lecture) the students present their work • After 6 months after the students got their projects they have to hand-in the final result of their project work • Some lectures about academic work are completing the module Remark: The projects are being worked on in groups
Examination requirements	Written paper, poster presentation, presentation

German language

Semester	Fall semester and Spring semester
Learning objectives	The courses will provide competence in speaking, reading and writing German according to the respective level of the Common European Framework (CEFR).
Textbook	Menschen: Deutsch als Fremdsprache – Kursbuch Hueber-Verlag Menschen: Deutsch als Fremdsprache – Arbeitsbuch Hueber-Verlag Supplementary material provided by course coordinator
Mode of Evaluation	Written exam (and course participation where applicable)

Intensive Course in September (voluntary):

German Language Intensive Course	Lessons per week	Credit points
Beginner Level 1 (A1.1)	30 (5 x 6 lessons, 2 weeks)	2
Ankommen in Deutschland Language and Culture (Previous knowledge of A2 required)	30 (5 x 6 lessons, 1 week)	2

Language Courses during term:

German as a Foreign Language	Lessons per week	Credit points
Beginner Level 1 (A1.1)	8	2
Beginner Level 2 (A1.2)	4	3
Elementary Level 1 (A2.1)	4	5
Elementary Level 2 (A2.2)	4	5
Intermediate Level 1 (B1.1)	4	5
Intermediate Level 2 (B1.2)	4	5

Performance Management

Course of Study	International Energy Economics
Semester	Spring Semester
Identification of Module	Controlling and Cost Accounting
Abbreviation if required	CKLM
Work load	45 minutes x 4 per week 90 minutes exam 150h
Credit points	5 ECTS-Credits
Prerequisites	Basic accounting skills
Educational objective / Competency	Upon completion of this course the students will be able to: 1. Understand the basics of financial and management accounting as well as the difference between direct and indirect, mixed, variable and fixed costs and the resulting implications for businesses. 2. See the importance of KPIs for business and team performance. Understand how different KPIs interrelate. 3. Find examples in real-world situations where non-financial performance measures are needed to assist decision-making. 4. Apply different methods of product costing, activity-based costing and inventory accounting when needed. 5. Understand and correctly interpret current texts about the financial topics discussed in class.
Content	

Week	Topics
1	Introduction to Performance Management and Cost Accounting, difference between accrual accounting and cash accounting
2	Management Accounting Overview and Professional Ethics; period-end accounting and continuous accounting; US-GAAP and IFRS
3	Financial Accounting continued US-GAAP text and example
4	Balance Sheets, Income Statements and Cash Flow Statements in different GAAPs and IFRS
5	Going Public, Going Private, ICO and VUCA
6	Share deals and assets deals; rolling forecasts; the treasury

		7	Performance Measurement to Support Business Strategy
		8	Value-based Management and Various Key Figures from Alpha to EVA
		9	The Balanced Scorecard
		10	Cost Accounting Basics; Cost Behavior
		11	Cost-Volume-Profit Relationships; Activity-based Costing
		12	Product Costing: Cost Allocation; Pricing Decisions
		13	Accounting for Inventory
		14	Revision

Analytics for Energy Data

Course of Study	International Energy Economics
Semester	Fall semester
Identification of Module	Analytics for Energy data
Abbreviation if required	AFED
Semester	5
Academic form / SWS	4
Work load	150 hours
Credit points	5 ECTS-Credits
Prerequisites	Basic database and SQL knowledge. Basic programming skills are useful.
Educational objective / Competency	Upon completion of this course the student will be able to: 1. Follow the CRISP-DM Process for data centric projects 2. Model a relational Data Warehouse database 3. Perform an ETL process including data quality assessment 4. Transform data for the application of analytic methods 5. Set up a relational Data Warehouse 6. Design reports including diagrams and pivot tables 7. Use a tool to obtain and employ Data Mining models, e.g. decision trees or association rules
Content	

Week	Topics
1	Basic techniques I: Working with desktop and client-server databases
2	Basic techniques II: Creating visualizations and pivot tables for reports
3	The CRSIP-DM process model and Case Study I: Business Understanding (based on House Automation data)
4	Case Study II: Data Understanding and ETL
5	Case Study III: Data Preparation - Part 1 using multidimensional data models
6	Case Study IV: Data Preparation - Part 2 using a staging area and transformation scripts
7	Theory of Data Warehouses and Case Study V: Implementation - Setting up the Data Warehouse
8	Case Study VI: Deployment (Performing analyses)
9	Data Mining I: Classification methods
10	Data Mining II: Association Rule Learners
11	Exams

Forms of Media	The course is primarily designed as an E-Learning course with practical exercises requiring computer use. The students are required to bring their own external USB hard disks!

Written materials	Witten/Frank: Data Mining, Morgan Kaufman, 4th ed.

Energy Efficiency

Course of Study	International Energy Economics
Semester	Fall Semester
Identification of Module	Energy Efficiency
Prerequisites	First and second law of thermodynamics Thermodynamic properties of materials (ideal gas, steam, liquids) Basic knowledge about heat transfer and fluid dynamics
Course learning objectives	Students will be able to: 1. Understand the fundamentals and the technologies of the most important indus-trial energy conversion processes. 2. Calculate energy efficiency indicators and illustrate energy flows. 3. Analyze manufacturing processes in respect of their energy consumption. 4. Understand how energy management systems can be integrated into the manufacturing processes. 5. Evaluate various industrial energy supply networks (compressed air, steam systems, hot water supply) in respect of energy efficiency. 6. Find solutions to reduce the energy consumption of manufacturing processes and industrial energy systems.
Content	About 25% of the final energy consumed in the EU is utilized for industrial processes. Increasing energy efficiency in this sector is one key target to reduce the emission of greenhouse gases on one hand and the economic dependency on energy prices on the other hand. In the first part of the course the relevance of energy as resource for manufacturing processes will be discussed. General methodologies to improve energy efficiency on basis of energy balances and energy flow analysis will be shown. Energy efficiency indicators will be introduced to evaluate and judge energy efficiency improvements in the context of manufacturing. The second part of the course deals with the optimum design of energy-efficient industrial networks and energy conversion processes. Compressed-air, steam and condensate systems will be discussed in detail. Some key components in manufacturing processes, for example electric drives and furnaces are studied in respect of their energy balance. The knowledge and methods will be applied in a team exercise, which is mandatory for all participants.
Topics covered	

Week	Topics
1	Basic statistics about energy supply and energy consumption in industry, trade and commerce; energy types; industrial energy systems
2	Energy indicators (specific energy consumption, cumulated energy demand, energy efficiency factor), Characterization of systems, energy balances

	3 -4	Energy flow charts, First and second law efficiency, exergy
	5	Energy management systems, methodology of energetic optimization, economic aspects of energy efficiency
	6	Industrial energy networks (compressed air, exhaust and supply air systems, heat recovery)
	7	Hot water and steam systems, lubrication and cooling systems
	8	Energy efficient drive systems, transportation of fluids and materials
	9	Energy balances of furnaces, drying processes
	10-11	Teamwork and Presentation
Textbook	Prof. Dr. Kleiser: Script	
References	Integrated Pollution Prevention and Control: Reference Documentation on Best Available Techniques on Energy Efficiency. European Commission, 2008	

Statistics

Course of Study	International Energy Economics
Semester	Fall Semester
Identification of Module	Statistics
Prerequisites	Mathematics
Course learning objectives	Passing the course means that one has obtained some basic statistical understanding – what is probability, how to test hypothesis and how to extract information from a set of observations. **Professional skills:** • Conduct a risk analysis based on a data set • Analyze the coherence between two data sets **Methods learned:** • Fit a linear modelt to a data set • Verify hypothesis based on data • Fit a distribution to a data set • Compute various risk measures • Handling data sets using the software R **Extrafunctional skills**: • Structure and solve complex problems • Handle problems with stochastic elements
Content	Statistics or data analysis appears nearly everywhere in daily business live and in particular in the energy business. Customer demand is unknown and has to be forecasted given a data sample, solar power and wind production are stochastic as well. At the same time, with digital devices everywhere, huge data samples are collected continuously. In order to extract information from them, statistical knowledge is required. This lecture provides a fundamental introduction to the field of statistics including practical application using the Software R.
Topics covered	The lecture covers the topics as listed below: • Univariate and multivariate data analysis, • discrete and continuous random variables and their distributions, • distribution fitting methods, • practical applications of random variables, • sample theory, • ANOVA, • hypothesis testing, • probability theory

Project Management

Course of Study	International Energy Economics
Semester	Fall Semester
Identification of Module	Project Management
Course learning objectives	Since projects are omnipresent in professional environments of all kinds, the competencies acquired from this module are certainly a profound and necessary basis for a later professional career. **Professional skills:** • Students know the basic terms of PM. • Students understand the functioning of various PM sub methods. • Students apply the PM sub methods on their own project. • Students understand the limitations of classic PM and know basic aspects of agile methods. • Students understand the variety of necessary skills for successful PM, in particular regarding leadership, motivation, and communication. **Methodological skills:** • Students graphically elaborate the progress and results of their own project. • Students present their own project to fellow students. • Students present in a given topical framework and time setting. **Other skills:** • Students apply insights, knowledge, and skills of the course - in particular of leadership, motivation, and communication - also to their everyday life. • Students form student teams themselves. • Students discuss about and agree upon a suitable project setting for their own team project. • Students regularly work in teams shouldering the responsibility fully themselves, applying various PM methods to their team project and preparing the presentations.
Content	**Key content is:** • Project definition, goals and objectives, SMART • Work breakdown structure, work packages, milestones, and phases • Project schedule, critical path, and float • Cost budgeting, resource and capacity planning • Risk management and stakeholder analysis • Limitations of classic PM: Simultaneous Engineering, SCRUM, etc. • Skills of a PM: leadership, motivation, communication, etc.

Textbook	Project Management Absolute Beginner's Guide by Greg Horine 2017 The Fast Forward MBA in Project Management by Eric Verzuh 2015

Energy Regulation

Course of Study	International Energy Economics
Semester	Fall Semester
Abbreviation if required	ENRE
Work load	150 hours
Credit points	5 ECTS-Credits
Expected competences	Fundamentals of energy economics from the previous semesters
Significance for the qualification	The aim of the module "Energy Regulation" is to provide students with a comprehensive knowledge of the most important principles of energy regulation that will be needed in their future professional practice. Upon successful completion of the module, students will understand the principles of regulation and the fundamentals of the energy industry, in particular electricity transmission, in theory and practice.
Content	The acquisition of the competences and skills mentioned below is achieved by addressing the following topics: • Theory and principles of energy regulation • Principles of the liberalised energy market • Electricity systems • Grid development • Economy and grid • System security • European regulation • Incentive regulation • Tariff design • Offshore grid expansion • Energy Policy • Excursion
Examination	Exam at end of semester
Learning outcomes	**Professional competence:** After successful completion of the module, students will be able to • understand the basic principles of national and international energy regulation, • distinguish between monopolistic and competitive market fields and apply regulatory models, • gain an overview of the tasks of a network operator and analyse them using case studies, • understand and evaluate current developments in the energy industry (e.g. coal exit), • reflect legal framework conditions at the national and international level.

	Competence in methodology: • Development of case studies with reference to the energy industry • Application of the acquired knowledge for the exemplary calculation of network charges • Active participation in a business game using the business model of a transmission system operator **Social and personal competence:** • Individual work and work in small groups to prepare the contents of the lectures • Present developed content in front of the course and improve it through feedback from the course • Discuss current topics after preparation with speakers from the practice • Independently deepen the acquired technical and methodological competence through exercises
Literature	Pérez-Arriaga, Ignacio J.: Regulation of the Power Sector

Energy Meteorology

Semester	Fall Semester
Abbreviation	EMET
Academic form / SWS	4 SWS
Credit points	5 ECTS-Credits
Prerequisites	Basic knowledge on solar and wind energy systems is helpful but not mandatory
Educational objective / Competency	• Introduction to challenges of energy meteorology • Introduction to weather and climate data sources • Knowledge on solar and wind energy resource estimation • Competence in the utilisation of meteorological data to calculate energy output of photovoltaic power and wind energy systems. • Competence in the validation of solar and wind energy forecasts • Utilisation of knowledge and competences in a self defined use case
Topics covered	Solar Energy • Overview of solar radiation resource concepts • Measureing solar radiation • Modeling solar radiation • Solar resource data and quality assesment • Forecasting solar radiation and photovoltaic power • Applying solar resource data to solar energy projects Wind Energy • Introduction to wind energy resource • Measureing wind energy • Wind energy data and quality assessment • Wind energy description and representation of its characteristics • Modeling of wind energy • Applying wind resource data to wind energy projects • Climate change impacts on wind energy
Computer Usage	Data analysis, application of industry specific software
Mode of Evaluation	Case Study on solar and wind energy use cases (oral presentation and report)
Examination requirements	Regular participation in the seminar
Examination	Oral presentation and report
Textbook / Literature	Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications: Third Edition (www.iea-pvps.org)
References	https://iea-pvps.org/research-tasks/solar-resource-for-high-penetration-and-large-scale-applications/

Germany within Europe

Identification of Module	Germany within Europe
Semester	Fall semester (October – Feburary)
SWS	4 sessions of 45 minutes per week
Credit points	5 ECTS-Credits
Course learning objectives	Upon completion of this course the student will be able to: 1. Explain effects of major historical events on German life 2. Demonstrate knowledge of periods of German history 3. Demonstrate through comparative analysis knowledge of present and historical background of Germany within its relations to Europe and U.S. 4. Demonstrate critical thinking skills through tracing main historical concepts in actual historical events
Content	This course explores most important topics in the history Germany in the context of European history. Emphasis is placed on developing an understanding for major political, social and economic aspects of German history and on tracing the German historical experience in its context. The comparison of historical time periods between European and U.S. history provides grounds for exploration of German history and German relations with other countries throughout the world.
Required Reading	Axelrod Alan, Phillips,Charles: What everyone should know about the 20th century; Adam Publishing, Holbrook MA, 1995 Tarnas, Richard: The passion oh the Western mind, Understanding ideas that shaped the Western World View; Random House Toronto, 1993 Facts about Germany, Societäts-Verlag, Frankfurt 2000
Mode of Evaluation	Attendance and reading required, one written test, one presentation on a relevant topic Distribution: Participation 30%, Test 40%, Essay 30%
Computer usage	Basic computer skills (MS Word)
Textbooks	Buchner, Rudolf: Deutsche Geschichte im Europäischen Rahmen; Wissenschaftl. Buchges. Darmstadt, 1975 Burns, Rob: German Cultural Studies, an Introduction; Oxford University Press, New York, 1995 Der große PLOETZ, Herder Verlag Freiburg 1998 Gebhardt, Bruno: Handbuch der Deutschen Geschichte, Union Verlag Stuttgart

	Gilbert, Felix; Large, David Clay: The End of the European Era, 1890 to the Present, published within the Norton History of Modern Europe Series, New York 1991 Hartwich, Hans-Hermann: Politik im 20.Jahrhundert; Westermann Verlag 1974

Operations Research

<table>
<tr><td>Course of Study</td><td>International Energy Economics</td></tr>
<tr><td>Semester</td><td>Spring semester</td></tr>
<tr><td>Identification of Module</td><td>Operations Research</td></tr>
<tr><td>Academic form / SWS</td><td>Four weekly lecture sessions of 45 minutes each</td></tr>
<tr><td>Work load</td><td>150h</td></tr>
<tr><td>Credit points</td><td>5 ECTS-Credits</td></tr>
<tr><td>Prerequisites</td><td>Mathematics of the first and second semester</td></tr>
<tr><td>Course Learning Objectives</td><td>Upon completion of this course the student will be able to:
6. Model simple economic problems like production planning, cutting problems, transportations problems, project planning and storage planning.
7. Solve the above mentioned models using well-known algorithms like the Simplex algorithm, the Dijkstra or FIFO algorithm, Stepping-Stone method or the Critical Path Method.
8. Map the real problems to the right class of models and know which assumptions are relevant and have to be fulfilled.
9. Find easy heuristics for different problems her-/himself.
10. Program the described algorithms in a computer language he knows.</td></tr>
<tr><td>Topics Covered</td><td><table><tr><th>Week</th><th>Topics</th></tr><tr><td>1</td><td>Introduction to Operations Research</td></tr><tr><td>2</td><td>Modeling of economic problems</td></tr><tr><td>3</td><td>Modeling of economic problems</td></tr><tr><td>4</td><td>Matrices and linear programming</td></tr><tr><td>5</td><td>Graphical solution of LP</td></tr><tr><td>6</td><td>The Simplex method</td></tr><tr><td>7</td><td>Excursion Week</td></tr><tr><td>8</td><td>Theory of graphs and networks</td></tr><tr><td>9</td><td>Shortest-route</td></tr><tr><td>10</td><td>Minimal spanning tree</td></tr><tr><td>11</td><td>Advanced LP – transportation models and its variants</td></tr><tr><td>12</td><td>Advanced LP – transportation models and its variants</td></tr><tr><td>13</td><td>Network and project planning</td></tr><tr><td>14</td><td>Inventory Management</td></tr><tr><td>15</td><td>Exams</td></tr></table></td></tr>
<tr><td>Mode of Evaluation</td><td>90 minutes exam</td></tr>
<tr><td>Computer Usage</td><td>Some models and algorithms are being shown on the computer</td></tr>
</table>

Energy Trading and Risk Management

Course of Study	International Energy Economics
Semester	Spring semester
Identification of Module	Energy Trading and Risk Management
Abbreviation if required	ETRM
Semester	5 or 4 respectively
Academic form / SWS	4 SWS
Work load	150h
Credit points	5 ECTS-Credits
Prerequisites	Basics of statistics stochastic
Educational objective / Competency	The liberalization of the energy sector extends the requirements on entrants to the electricity and the gas industry fundamentally. The other energy commidities like coal, oil and CO2 face these problems and requirements respectively since years. Due to the becoming and the existence of the wholesale and the exchange prices in the spot and derivatives trading, the whole, more technically oriented, value chain, which consists of the sectors generation, grid and distribution, is affected. The trade market prices influence the short-term deployment of power plants and give signals for long-term investment decisions. Within the scope of the course the basics of energy trading and the accompanying risk management is been illustrated. Cross border, long-term and short-term trading simulations, the "Energy trader for one day"-experience completes the module.
Content	Introduction in the energy trading • Overview on the value chain - Classification of the trading between electricity generation and distribution • Tradable commodities, trading market and the link to the physically generation • The role of the energy trading • Advantages and reasons of trading Trading purposes (Hedging, Arbitrage, Speculation) • Trading center (exchanges, OTC, eOTC) • Standardization • Link to physical supply of electricity: accounting grid, regulation zones/ market areas, timetable management, prices for balancing energy • Organization of trading and trading participants

	Structure of a trading organization • Spot market, derivatives market • Market products: Forwards, Futures, Options • Price formation in the energy trading Spot market - Link of the spot prices to the power plant deployment • Derivative market – Basis for long-term investment decisions • Clearing • Trading strategy Basis for the trade – Arbitrage of the resulting price differences in the physical energy market and gas market • Option strategies and option assessment • Optimization of forward positions • Power plant deployment planning Long-term hedging Short-term daily deployment planning Introduction in risk management • Overview • Role of the risk management in a trading organization • Price risk management and credit risk management • Price risk management and credit risk management • Price risk management • Credit risk management Pricing Simulations • Cross border • Short-term • Long-term
Written materials	Markus Burger and Bernhard Graeber and Gero Schindlmayr: "Managing energy risk: An Integrated View on Power and other Energy Markets", 2003, John Wiley \& Sons, Ltd., Hoboken, New Jersey “Energy Risk” of Dragana Pilipovic. German sources would be “Handbuch Energiehandel” of Schwintkowski and “Energiehandel in Europa” of Zenke and Schäfer.

Data Management in Energy Markets

<table>
<tr><td>Course of Study</td><td>International Energy Economics</td></tr>
<tr><td>Semester</td><td>Spring semester</td></tr>
<tr><td>Identification of Module</td><td>Data Management in Energy Markets</td></tr>
<tr><td>Abbreviation if required</td><td>EDAT</td></tr>
<tr><td>Semester</td><td>5</td></tr>
<tr><td>Work load</td><td>150h</td></tr>
<tr><td>Credit points</td><td>5 ECTS-Credits</td></tr>
<tr><td>Prerequisites</td><td>Basic knowledge of central and decentralized energy systems and energy economy</td></tr>
<tr><td>Educational objective / Competency</td><td>Upon completion of this course the student will be able to:
1. Understand the role model of the energy market in Europe
2. Model a price settlement at the energy stock exchange (EEX) with the merit order.
3. Describe the energy economics of the German Feed in Law and analyze the influence to the energy prices at the EEX. Map
4. Estimate the potential of load shifting in private households
5. Calculate the amount of solar electricity to be directly used in a household
6. Evaluate the error of wind and solar power predictions</td></tr>
<tr><td>Content</td><td>
<table>
<tr><th>Week</th><th>Topics</th></tr>
<tr><td>1</td><td>The role model of the liberalized energy markets in Europe</td></tr>
<tr><td>2</td><td>Price settlement with merit order</td></tr>
<tr><td>3</td><td>Contracts and business processes in the energy market</td></tr>
<tr><td>4</td><td>The energy stock exchange market</td></tr>
<tr><td>5</td><td>Power flow analysis of wind and solar power systems</td></tr>
<tr><td>6</td><td>Energy meteorology, wind and solar power forecast</td></tr>
<tr><td>7</td><td>Project</td></tr>
<tr><td>8</td><td>Project</td></tr>
<tr><td>9</td><td>Project</td></tr>
<tr><td>10</td><td>Project</td></tr>
<tr><td>11</td><td>Project-Presentation</td></tr>
</table>

Four weekly seminar sessions and two lab sessions of 45 minutes each. Maximum of 20 participants</td></tr>
</table>

Examination requirements	30 Minutes oral presentation (30%) and written project Report (70%), attendance at 80% of the seminar.
Forms of Media	Intensive use of Excel

Seminar in Energy Economics

Course of Study	International Energy Economics
Semester	Spring semester
Identification of Module	Seminar in Energy Economics
Academic form / SWS	Seminar
Work load	150h
Credit points	5 ECTS-Credits
Educational objective / Competency	The student familiarizes himself with a specialiced topic in energy economics, by reading of original literature, by presenting the topic to an audience, and by producing a final paper.
Content	• In the first week of the semester (after the lectures started) the students can choose a seminar topic put of a set of different papers • In the second half of the semester all of the students present the paper study Remark: The work in the seminar is being done alone, not in groups.
Examination requirements	The given presentation, together with answering question concerning all the presentation and an additional group work

Elements of Complex Systems Simulation

Course of Study	Elective / International Energy Economics
Semester	Fall semester and Spring semester
Identification of Module	Simulation
Abbreviation	ECCS
Academic form / SWS	4 SWS
Work load	150 h
Credit points	5 ECTS-Credits
Prerequisites	Logical thinking, basic mathematics, joy in getting a deeper understanding of complex systems.
Impact for Professional Career	There is a huge number of important questions both in the industrial and social context, which might only be answered by means of simulation; some famous examples cover climate change and virus spreading. Furthermore, complex systems such as markets or social networks are not only omnipresent, but also relevant for financial or economic success. Accordingly, the ability to generate knowledge about complex systems and their sometimes surprising behaviour by setting up proper models, implementing and finally simulating them can't be overestimated in a professional career.
Educational objective / Competency	Upon completion of this course students have achieved the following skills. **Professional skills:** Students - know the advantages of simulation. - know, when it is reasonable to do a simulation and when not. - are able to classify simulations. - understand the general procedure of simulation application. - understand the peculiar properties of complex systems. - are able to implement, verify, and evaluate simulations about the course content themselves. - understand the underlying mechanisms of typical economic phenomena such as market cycles and cost cutting pressure. - understand the influence of strategies and cartels on the market situation. - know a variety of stochastic systems. - know analytical models and methods for describing and calulating complex systems, in particular stochastic ones. - are able to choose the suitable model or method and apply it correctly to given questions of relevance. - know about simulation techniques and concepts for dynamic systems.

	Methodological skills: Students - abstract key features of a system for model design. - implement simulations in Python, Mathematica, Matlab, Excel or other software. - evaluate results, and display them graphically. - derive relevant results in a mathematical, analytic manner. - interprete results with respect to further related problem settings. **Other skills:** Students - deepen and extent the above-mentioned key competencies of the course themselves in a systematic way. - train the ability of problem-oriented discussions in smaller groups. - apply insight and knowledge from the course to corresponding problem settings in their everyday life or the private sector.
Content	**Key content is:** • Market Dynamics • Stochastic Systems • Markov Chains • Queuing Systems • Discrete Event Simulation • Propagation
Examination	Written exam (90 min)

Germany In The Last Three Centuries

Identification of Module	Germany within the last three centuries
Semester	Spring semester (March – July)
Curriculum specification	1. An Overview of German history up to and including reformation and the Thirty Years War. 2. Culture, society, and political developments in the 18th century. The rise of Prussia. The impact of the French revolution. 3. Reform and liberation. German federation. German nationalism in the 19th century as expressed in music and literature. 4. Revolution in 1848. Bismarck and his struggle for Prussian hegemony. 5. The German Empire & the 1st World War. The foundation of the Reich. Bismarck's domestic policy. Colonial policy. The culture of the Wilhelmine Empire. Crises and naval building. The 1st World War. 6. The Weimar Republic. Foundation of the Republic. The Versailles Treaty. Crises & fulfillment. The collapse of the republic. 7. Nazi Germany & the 2nd World War. The pseudo-democratic establishment and consolidation of the Nazi state. Social life and economic policy. The 2nd World War. Concentration camps and the Holocaust. The collapse of Nazi Germany. 8. The aftermath of the wars. Germany under occupation. The Iron Curtain. The foundation of the Federal Republic and the German Democratic Republic. Integration in different systems of alliances. 9. Detente and German reunification. The economic miracle in West Germany. West Germany's "east policy". The collapse of East Germany. Reunification and consolidation.
Work load	Four class periods per week
Credit points	4 ECTS-Credits
Prerequisites	none
Course learning objectives	Each student who receives credit for this course will have demonstrated the ability to do all of the tasks listed below: 1. Describe and explain the political developments in and around Germany for the period under discussion 2. Describe and explain the socio-cultural evolution in Germany for the period under discussion 3. Explain the development of the German political system 4. Explain attitudes and customs in present-day Germany from an historical viewpoint
Content	German history up to and including reformation and the Thirty Years War; culture, society, and political developments in the 18th century; reform and liberation; German federation; revolution in 1848; Bismarck and his struggle for Prussian hegemony; the German Empire & the 1st World War; the Weimar Republic; Nazi Germany &

	the 2nd World War; the aftermath of the wars; detente and German reunification
Textbooks	Martin Kitchen: *Cambridge Illustrated History of Germany*, Cambridge University Press, Cambridge 1996 Numerous source materials (print, audio, video) in English or in English translation (to be distributed in class)

Energy Storage

Semester	Spring Semester
Prerequisites	Basic engineering
Textbook	Prof. Dr. Walter Commerell Energy Storages
References	• Diekmann Bernd, Rosenthal Eberhard: Energie – Physikalische Grundlagen ihrer Erzeugung , Umwandlung und Nutzung. Springer Spektrum, Wiesbaden, 2014 • Sterner Michael, Stadler Ingo: Handbook of Energy Storage, Demand, Technologies, Integration, Springer Heidelberg 2019 • C.H. Hamann, A. Hamnett, W. Vielstich: Electrochemistry, Wiley-VCH, Weinheim, 2007 • C. Julien et al.: Lithium Batteries Sciences and Technology, Springer Heidelberg, 2016 • S. Panero: Electrochemical Theory – Thermodynamics, Elsevier, 2009 • Thielmann et al.: Energiespeicher-Roadmap (Update 2017) Hochenergie-Batterien 2030+ und Perspektiven zukünftiger Batterietechnologien, Fraunhofer-Institut für System- und Innovationsforschung ISI, Karlsruhe, 2017
Credit points	5 ECTS-Credits
Course Learning Objectives	The objective of the lecture is to give an overview on different energy storage systems. The student learn how the system is structured, state of the art technologies and a research outlook about upcomming technologies and solutions. Upon completion of this course the student will be able to: 1. Understand the principle technologie and the manufactorers information 2. Compare different storage solutions 3. Design a energy storage system 4. Consult others about possible solutions
Content	Energy Storages are used to deal with volatile energy sources as the renewable energy sources like solar-, wind- or hydropower. They store the energy when available and supply loads when needed. Energy storages are one technical element in the transformation of the energy system from fossil energy sources to renewable sources. The lecture cover an introduction into energy storages and discuss parameters of energy sources needed in analysis or design of such systems. Within the lecture, energy storages like mechanical storages with pump- , compressed air-, spring- , fly-wheel and mass storages are discussed and analyzed based on several examples. Electrical storages like capacitor and inductance discussed with their application. Thermal storages with sensible and latent as well as

	thermos chemical storages are shown with their potential. Chemical storages with fossil, hydrogen storage possibilities and bio mass storages are analyzed. The lecture focus on electrochemical storages with different battery types and battery systems as Lithium Ion energy storages for stationary and mobile solutions.
Schedule	Four weekly lecture sessions of 45 minutes each
Computer Usage	For research and design simulation
Mode of Evaluation	written or oral examinationl test
Distribution	mid-term test 50%, final test 50%

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