Module name: Energy and Green Production I: System Solutions for Industry, Energy-Efficiency

Module number: B 2	**ECTS credit points: 5**
Academic level	Master
Intended curriculum phase	2nd sem.
Compulsory module or compulsory elective module	Compulsory module
Ratio of in-person/online teaching	1.5 in-person teaching / 3.5 online teaching
Assigned courses*/ stages / ECTS credit points *… Course types and associated workloads are explained in detail under planned didactics and methodology	1. Basics of Digitisation in Energy Systems (Grundlagen der Digitalisierung im Kontext von Energiesystemen); e-learning course – **online stage**, 1.5 ECTS credit points 2. Energy and Production I – System Solutions for Industry, Energy-Efficiency; lecture / case studies – **in-person stage**, 1.5 ECTS credit points, VU (lecture with integrated exercises) 3. Transfer Project; e-learning project – **transfer stage**, 2 ECTS credit points, PT (project)
Scope	5 ECTS credit points
Required skills/modules; skills/modules to be acquired in parallel	none
Prerequisite for	Energy and Green Production II

Course language	English
Central idea and skills to be imparted	In this module, students gain a systemic overview and a comprehensive understanding of the Austrian energy system and its integration into the European network. In addition, technical backgrounds, regulatory framework conditions and basics of the energy markets are discussed. The skills acquired in this way can be used in the context of system analyses and strategy development processes. In addition, the transformation of the energy system is analysed and discussed, along with sufficient basic knowledge for recognising the challenges for the energy system and the energy system analysis. Building on this, students acquire knowledge of the basics of energy system analysis and specific scientific methods. This fundamental know-how is then used to understand, discuss and develop solutions and strategies for the transformation of the energy system, as well as to assess their influence on the energy system and the industry. The final part of the module thus focuses on the strategies and solutions required for the transformation of the energy system. Among other things, students learn about future technologies, the use of optimisation methods (internal and external), sector coupling and hybrid networks. After successful completion of the module, the knowledge and skills of scientific methods become utilisable and consolidated. Using exercises, case studies and calculation exercises, students are able to apply the knowledge and skills acquired. They are able to apply what they have learned and to initiate and implement independent analyses and evaluations as part of operational decisions. They are also able to apply appropriate strategic measures efficiently and in a targeted manner.

Teaching content	**Learning outcomes / goals**
	Upon successful completion of the module, students are able to:
Basics of the Austrian energy system • Development of the Austrian energy supply system: electricity, heating and gas networks • Technical background • Regulatory framework (e.g., energy communities) • Market systems • Integration into the European system	• use the knowledge about the structure, the technical background and the regulatory framework of the existing energy system • understand the transformation of the energy system, including the decisive influencing factors, in order identify challenges for networks and industry • apply methods for energy system analysis correctly and appropriately according to their range of application

Transformation of the energy system • Network challenges • Challenges for the industry • Challenges for the energy system analysis	• recognise the challenges of the energy system transformation in order to identify measures (strategies and solution approaches) • evaluate the effects and influences of transformation processes and measures on the basis of scientific methods • develop solution approaches for the implementation of new technologies in existing energy systems
Methods of energy system analysis • Energy and exergy balancing • Methods for energy system optimisation • Methods of operational optimisation	• use scientific methods for energy system analysis and optimisation in transformation processes • assess technological developments • develop technological concepts to support strategic decisions • assess the potential and risks of transformation processes and develop strategies for successful implementation
Strategies and solution approaches, as well as their influence on the transformation of the energy system • Future technologies • Energy efficiency measures • Design and optimisation of energy systems (internal and external) • Sector coupling • Hybrid networks	
Exercises, case studies, calculation exercises	

Teaching and learning activities and methods*	**Planned didactics and methodology:**
*… teaching and learning activities and methods along with their structuring are explained under planned didactics and methodology	**In-person teaching units:** • The in-person stage is conducted as a mixture of front-of-class, question-based and discussion-based teaching and with much time devoted to joint discussion (whole-class, in groups). • Examples to illustrate and consolidate the teaching content are used. • Flipped classroom elements **Project:** • Group work • Self-directed learning • Independent preparation and follow-up of the teaching content • Application of the teaching content in practice-relevant tasks

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<tr><td></td><td>Breakdown of time commitment:
<table><tr><th></th><th>Estimated time commitment in units of 60 minutes</th></tr><tr><td>In-person teaching units</td><td>25</td></tr><tr><td>Course assessment</td><td>50</td></tr><tr><td>Project</td><td>50</td></tr><tr><td>Total</td><td>125</td></tr></table></td></tr>
<tr><td>Assessment</td><td>Assessment methods and criteria:

The in-person stage is assessed by means of a written examination and by preparing and presenting a group task (case study discussions).

Weighting of the individual assessments in the overall assessment of the module:
<table><tr><th></th><th>Weighting</th><th>Minimum required positive assessment for a completion of the course on the first try</th></tr><tr><td>Written exam – in-person stage</td><td>50%</td><td>> 50%</td></tr><tr><td>Project report, project work</td><td>30%</td><td>> 50%</td></tr><tr><td>Project presentation</td><td>20%</td><td>> 50%</td></tr><tr><td>Total</td><td>100%</td><td>> 50%</td></tr></table>Any deviations from this description of the overall assessment are announced at the beginning of the module.</td></tr>
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<tr><td>Specialist literature and other learning materials</td><td>Core literature / books, each in the current edition literature in English and German (German-language selection below):
• Crastan, Valentin (2015): Elektrische Energieversorgung 1, Springer. ISBN: 978-3-662-45985-0
• Patel, Mukund R. (2012): Introduction to Electrical Power and Power Electronics, Crc Press Inc. ISBN: 978-1-4665-5660-7
• Schwab, Adolf J. (2009): Elektroenergiesysteme, Springer. ISBN: 978-3-540-92227-8
• Fratzscher, Wolfgang (1986): Exergie, VEB. ISBN: 978-3-7091-9524-6</td></tr>
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	• Pehnt, Martin (2010): *Energieeffizienz*, Springer. ISBN: 978-3-642-14250-5 • Schäfer, Norbert (2000): *Fernwärmeversorgung*, Springer. ISBN: 978-3-540-67755-0 • Homann, T. et al (2016): *Handbuch der Gasversorgungstechnik*, DIV. ISBN:978-3-8356-7299-4
	Other learning materials: ▪ TU Graz learning videos (20-30 min.) ▪ screencasts and slidecasts ▪ other free learning and teaching materials ▪ PPT slides