

Module level Master	Credit points 6	Language English	Return annual
Module designation			
Technical and Economic Aspects of Grid Integration			
Course(s)			
1. Electrical engineering aspects of grid integration 2. Economic aspects of grid integration			
Code	Subtitle		
Person responsible for the module	Prof. Dr. rer. nat. Clemens Hoffmann		
Lecturer	1. Dr. Philipp Strauß, Thomas Degner(tbc.), Gunter Arnold (tbc.), Nils Schäfer (tbc.) 2. Dr. Kurt Rohrig, Reinhard Mackensen, Patrick Hochloff		
Workload	1. 90 h (10h online presentation, 10h contact time, 30h exercise, homework, 40h private study) 2. 90 h (10h online presentation, 10h contact time, 30h exercise, homework, 40h private study)		
Relation to curriculum	Specialist studies, Electrical Systems Technology, elective		
Type of teaching, contact hours	Virtual classrooms, online presentation, digital communication, skype		
Requirements according to examination regulations	Modules of Basic studies		
Recommended prerequisites	None		
Module objective / intended learning outcomes			
<p>1) Students have knowledge about methods of network planning within a wind farm and electrical design of transformer stations for grid connection of wind farms. They are familiar with system perturbations of wind farms corrective, measures for ensuring the required voltage and current quality, and the tasks of protection for the generating plant and the grid resources. They are able to define requirements for qualities of wind turbines and wind farms in Germany and are familiar with application, architecture and functionality of information and communication technology (ICT) in the wind farm.</p> <p>2) Students are familiar with general aspects of grid integration and support schemes. They know about the role and opportunities of ICT. They are able to describe the mechanism of energy and power markets and are familiar with risk management and portfolio management for wind energy traders. They have knowledge about frequency control, balancing, control power, ancillary services, flexibility options and virtual power plants.</p> <p>Competences: integration of knowledge, skills and social and methodological capacities in working or learning situations</p>			
Content			
<p>The course Electrical Engineering Aspects of Grid Integration provides basic knowledge on grid integration of wind energy systems. The grid integration is shown as a building block in the chain of power generation to supply the distribution or transmission network. Characteristics of this block determine authorization for the connection to the electrical power system and conformity of the wind farm with the operation of the existing network.</p> <p>The course Economical Aspects of Grid Integration provides basic energy-economical knowledge on grid integration of wind energy systems. The economic aspects of grid integration consider wind turbines equal in energy supply systems regarding market of power and control power and other</p>			

ancillary services. Furthermore, the opportunities for flexibility (virtual power plants, storage, load management, network expansion), the importance of forecasting and control of wind farms and wind farm clusters will be treated.

Support Schemes: description and impact

Role and opportunities of ICT: Standards, interfaces, architecture

Energy and Power Markets: description and impact

Portfolio Management, Trading of Wind Energy: forecasts and probability

Ancillary Services: Frequency Control, Balancing, Control Power, Voltage Control

Flexibility Options: Demand Side Management, Grid Extension, Storage

Virtual Power Plants: technical and economic aspects

Study and examination requirements and forms of examination	Written Exam (90min)
Media employed	Online script
Reading list	
<ol style="list-style-type: none"> 1. Turan Gonen: <i>Electrical Power Transmission System Engineering Analysis and Design</i>. ISBN-10: 1439802548; ISBN-13: 978-1439802540 2. Olivia E. Robinson: <i>Electric Power Systems in Transition (Electrical and Engineering Developments)</i>. ISBN-10: 1616689854; ISBN-13: 978-1616689858 3. James J. Burke: <i>Power Distribution Engineering: Fundamentals and Applications</i> (Electrical and Computer Engineering). ISBN-10: 0824792378; ISBN-13: 978-0824792374 4. Mohamed El-Hawary: <i>Electrical Power Systems: Design and Analysis</i> (IEEE Press Power Systems Engineering Series) ISBN-10: 078031140X; ISBN-13: 978-0780311404 5. Thomas Ackermann: <i>Wind Power in Power Systems</i>. ISBN-10: 0470974168; ISBN-13: 978-0470974162 6. J. Lewis Blackburn: <i>Protective Relaying: Principles and Applications</i> (Power Engineering (Willis)). ISBN-10: 1574447165; ISBN-13: 978-1574447163 7. Juan M. Gers, Ted Holmes: <i>Protection of Electricity Distribution Networks</i>. ISBN-10 0863413579; ISBN-13 978-0863413575 	