Number of module 3:	Module: Wind Energy
Coordinator of module	**Prof. Dr. T. Kampschulte**
Lecturer	**Prof. Dr. T. Kampschulte, Dipl.-Ing. K.-P. Lehmann (Guest lecturer)**
Term/Period of time/Frequency	2nd semester / within one semester / summer term
Credits	5
Workload	Workload 150 CP: on campus program 64 h (4 SWS), self-study 86 h
Status	Obligatory module
Prerequisites	Recommended: Precognition: electrical engineering, power engineering, mechanical engineering, fundamentals of measuring methods, electronics
Language	English

Skills to be acquired / Learning objectives

Subject based and methodical skills

The students are able ...

- to combine knowledge of different subjects systematically,
- to acquaint themselves with new content in a systematic way,
- to transfer theoretical knowledge to application,
- to interconnect and operate different technical devices of renewable energy generators,
- to apply and to develop suitable methods to analyze technical and scientific tasks,
- to document measurements in technical reports,
- to develop advanced knowledge about wind energy conversion systems. Students are trained and enabled to analyze locations according to the suitability for wind generators, to decide about appropriate wind turbines and to plan a wind farm with regard to technical, economical and environmental aspects. The course prepares students to work in planning office for wind energy projects, in the field of monitoring, service and maintenance of wind turbines or within environmental authorities.
- to introduce selected European energy policy with regards renewable energy,
- to discuss energy resource issues and the impact of wind energy projects,
- to discuss global and German energy use and its effect on the environment,
- to introduce wind energy conversion technologies as alternatives to fossil-based energy conversion,
- to understand and evaluate the wind energy sector as an industrial branch.

Personal and social skills

On completion of this module, students are able …

- to work in a team and to take responsibility in teamwork,
- to cope with complex technical tasks independently,
- to apply understanding of quantitative decision making techniques,
- to critically evaluate the environmental assessment of projects,
- to understand the complex nature of project assessment and critically evaluate theories, concepts, tools and models environmental impact analyses,

- to enable participants to formulate, evaluate and select from alternative technologies and location to meet legal requirements and financial interests,
- to understand and be able to explain German energy policy,
- to describe and assess the impact of wind energy projects,
- to calculate the power output wind energy projects,
- to make a critical appraisal between the technological efficacy and commercial feasibility.

Contents

Wind turbines

- Introduction:
  - History of wind energy, current status, economical importance
- Wind energy
  - Appearance of Wind, local effects, wind shear, turbulence, time variation
  - Measurement of wind, analysis of wind data, energy estimations
- Wind energy conversion systems
  - Technical concepts of conversion systems, vertical and horizontal axis, wind rotors
- Aerodynamics of modern wind turbines
  - Airfoil, Blade shape, momentum theory, rotor design
- Mechanics
  - Energy transmission, gear box, brakes, pitch control, azimuth control, housing, tower, base plates
- Electrical power generation
  - Electrical concepts, Generators, inverters, transformer, grid connection
- Operation of wind turbines
  - Power control, monitoring, servicing and maintenance

Assessment of wind energy projects:

- Wind energy markets, policies & support schemes
- Project development process & stakeholder analysis
- Assessment of potential sites, yield prognosis & optimizing, WT selection
- Permission procedures incl. environmental impact analyses
- Wind farm economics (AEP, CAPEX, OPEC and local content)
- Wind farm realization & operation
- Outlook: Offshore wind energy, repowering and innovations

Related courses

- Wind Turbines
- Assessment of Wind Energy Projects

Teaching skills	Power point presentations, students team work, arithmetic problems and exercises
Exam	oral or written exams
Literature / Teaching aids	• Lecture notes • E. Hau: Wind Turbines, 3rd edition, Springer, Berlin, 2013. • Gasch, Twele: Wind Power Plants: Fundamentals, Design, Construction and Operation, Springer, Berlin, 2012. • S. Heier: Grid Integration of Wind Energy Conversion Systems, Wiley & Sons, Chichester, 2006. • M. Sathyajith: Wind Energy - Fundamentals, Resource Analysis and Economics, Springer, Berlin, 2006. • Manwell et al.: Wind Energy Explained, Wiley, Chichester 2008. • T. Burton: Wind Energy Handbook, Wiley & Sons, Chichester, 2002. • V. Quaschning: Understanding renewable energy systems, Earthscan, London, 2007. • I. Freris, D. Infield: Renewable Energy in Power Systems, Wiley, Chichester, 2008.