Module Description

Electrical Energy Systems

General Information

Number of ECTS Credits

3

Module code

TSM_ElEnSys

Responsible of module

Vinzenz Härri, HSLU

Language

	Berne	Lausanne			Lugano	Zurich		
Instruction	☒ E 100%	☐ E 100%		☐ F 100%	☐ E 100%	☐ E 100%		☐ D 100%
Documentation	☒ E 100%	☐ E 100%	☐ E %	☐ F %	☐ E 100%	☐ E 100%	☐ E %	☐ D %
Examination	☒ E 100%	☐ E 100%	☐ E 100%	☐ F 100%	☐ E 100%	☐ E 100%	☐ E 100%	☐ D 100%

Module category

☐ FTP Fundamental theoretical principles

☒ TSM Technical/scientific specialization module

☐ CM Context module

Lessons

2 lecture periods and 1 tutorial period per week

Entry-level competencies

Prerequisites, previous knowledge

Basics of electrical laws, circuitries, components and energy conversion expected

Brief course description of module objectives and content

In this module, students will increase their knowledge in selected areas of energy production, energy distribution and energy utilization in the systemic environment. Emphasis is placed on modern topics of electrical energy, such as grid quality, energy storages, smart-grids or the European super-grid. The content consists of 4 parts:

- energy basics and market
- storages and smart-grids
- special chapters on TD (transmission and distribution)
- interconnected grids

Aims, content, methods

Learning objectives and acquired competencies

Students

- know the main challenges of today's modern grids
- know the main elements of an electrical grid and the differences of transmission components
- know the DC transmission technology
- know the worldwide importance of primary energies as regards the electricity market;
- can explain the market pressure by suppliers of fossil primary energy;
- know obstacles for the market entrance of renewable energies;
- know the significance and the possibilities of energy storages and are able to name at least two pro and two contras of each storage type in specific applications;
- know fundamental points in the integration of accumulators and supercapacitors;
- can describe the significance of smart-grids and there interaction with energy storages
- know who frequency stability can be reached and what errors can arise in the network and know how to protect the equipment;
- learn the basic principles of the management and regulation of electrical grids;
- learn to assess the dynamic stability of networks and know quality attributes of grids.

Contents of module with emphasis on teaching content

Course	Designation	Week
1	**Introduction, Energy and Market Topics**	
	Introduction, Energy policy, challenges modern grids	1
	The open electricity market is setting up the economic conditions	2
2	**Smart-grids, energy storage technologies and peak power handling**	
	Wanted! Energy storage technologies, not only for the electrical mobility!	3
	What about the integration of mobile, central / decentral energy storages?	4
	Smart-grids: change of paradigm & change for optimizations, but what for?	5
	The practical aspects of smart-grids: Case Study	6
3	**Special Chapters on T&D (Transmission and Distribution)**	
	From DC to AC: technical constraint for the electricity supply system	7
	Cables and overhead lines: visibility against costs and efforts	8
	Synchronous machines are the heart of the grid	9
	Power Quality – a constant and sinusoidal voltage is not a random	10
4	**Interconnected Grids**	
	Frequency & active power exchange under control by Swissgrid and friends	11
	Pure mathematics: Design and operation of meshed topologies	12
	From HVAC transmission to an DC Supergrid	13
	Swinging grids besides 50Hz: dynamic interaction and stability	14

Teaching and learning methods

- ex cathedra teaching
- weekly exercises
- presentation and discussion of case studies

Literature

Information on additional literature will occasionally be given during the module.

Assessment

Certification requirements for final examinations (conditions for attestation)

1 online revision test towards the end of the module has to be done and accepted for admission to the final examination (only admission condition but not part of the final grading).

Standard final exam for a module and written repetition exam

Kind of Exam	written
Duration of exam	120 minutes
Permissible aids	☐ No aids
	☑ Permissible aids:
	☒ Electronical aids: calculator
	☒ Hardcopy form: 2 A4 double-sided pages summary are permitted