Module Nr.	Credits	Workload	Semester	Frequency	Duration
SE-CO-13	10 CP	300 h	2	Yearly (SS)	1 Semester
Courses			**Contact time**	**Self-study**	**Group size**
a) Heating, Cooling and Storage			3 h/week	105 h	---
b) Electricity generation, district heating and industrial uses			3 h/week	105 h	

Geothermal Energy Systems

Learning outcomes

- After the course the students know how geothermal heat pumps can be used for heating and cooling. Students are able to dimension borehole heat exchangers (BHE) for small shallow geothermal systems (≤30 kW). They are also able to plan large systems which require a design by simulations. They can decide which design techniques and software is required for a specific site and project. The students know how a Thermal Response Test enhances the quality of the planning process and are able to interpret the measured data of the test.
- The students know the fundamentals of electricity generation from geothermal resources at low and at high enthalpy. They describe the function of the components of a power plant and understand the thermodynamics of fluid and steam cycles. They are able to design simple district heating networks and develop concepts for industrial applications for infrastructural and agricultural uses.

Content

a) Heating, Cooling and Storage

- Working principle, types of heat pump and potential applications
- Different shallow systems: borehole heat exchanger, horizontal collector and groundwater wells
- Planning of small shallow geothermal systems (≤30 kW)
- Design by means of the German guideline VDI 4640
- Simulation of borehole heat exchangers: What is a g-function?
- Calculation methods of common simulation software
- Range of applications and limits of simulation approaches
- Planning of large shallow geothermal systems (>30kW)
- Limits of the g-functions approach and numerical methods
- Numerical parameters: dependency between simulation errors and computation time
- Importance of TRT for the design of BHE, interpretation of the measured data

b) Electricity generation, district heating and industrial uses

- Global geothermal resources
- Elements of thermodynamics, fluid mechanics, and heat transfer applied to geothermal energy conversion systems
- Power plant technologies
- Cooling technologies, district heating networks and direct uses
- Pumping the reservoir
- Hybrid uses (water desalination)
- Mine water applications

• Corrosion and scaling processes • Social and environmental impacts • Casestudies • Economics, finance, and risk analysis of a geothermal project
Teaching Methods / Language a) Lectures (2h) / Exercises (1h) / English b) Lectures (2h) / Exercises (1h) / English
Modes of assessment Written final exam (120 min) and Thesis with colloquium for a) and b)
Requirements for the award of credit points Pass the final examination
Module applicability (in other study programs) -
Weight of the mark for the final score 8.33 %
Module coordinator and lecturer(s) Prof. Dr. R. Bracke
Other information