RENEWABLE ENERGY
(3 ECTS) *Elective*

The aim of the course is to introduce students to subject of renewable energy. Review of technologies applied in RES (solar thermal, solar electricity, wind, water, biomass, introduction to energy systems working with RES). General knowledge based on physics and mathematical models will be given. The course introduces to subject of renewable energy, shows how energy can be harvest from solar radiation, wind, water, biomass, geothermal and other renewable sources. The examples of the existing systems will be presented. New and emerging technologies devoted to future renewable energy systems efficiency will be presented. The laboratory exercises are devoted to solving problems connected with practical measurements of the examined model installations.
After you have worked through this course, including laboratory classes, you should be able to:

- Understand physical processes of harvesting renewable energy and have general knowledge as a basis for further study of particular installation technologies.
- Know the contemporary development of research and application of renewable energy resources and sources.
- Be familiar with the physical and technical aspects of the renewable energy systems, including its efficiency, controlling and available potentials and have basic knowledge about possibility of integration of renewable and classical energy systems.
- Perform measurements and tests for renewable energy installations, determine their efficiency and performance. Provide students with a package of practical information and abilities of working with renewable energy installations (solar, biomass, etc.)

Course main content

- Introduction to solar energy: solar constant, time equation, transfer of solar radiation through the atmosphere. Introduction to mathematical theory of solar collector, basic parameters of solar collector, construction and types, components. Examples of thermal solar installations
- Introduction to photovoltaic, band structure of solid state, photovoltaic effect, characteristics of the solar cells, full spectrum photovoltaic systems, hybrid systems: photovoltaics+thermics, thermophotovoltaics. Photovoltaic power plants.
- Wind energy: origin of the winds, wind power, Betz' law, basic parameters of the wind, different scale wind systems, small wind turbines, urban wind turbines, future technologies of wind energy conversion. Wind energy systems.
- Water energy, different scale water energy systems, turbine types, ocean energy (OTEC, tidal, wave, salinity difference, etc.). Conversion of water energy.
- Origin of geothermal energy, geothermal energy systems, ground heat exchangers, heat pumps.
- Biomass energy and biomass energy systems – thermal and electric energy and integration with other energy systems (e.g. with fuel cells).
- Technologies devoted to storage and transfer, their compatibility with RES, introduction to virtual power plants
- Laboratory: students measure performance of solar flat-plate and evacuated collectors, efficiency of photovoltaic module with/without the Sun tracer, test efficiency of model energy systems (wind turbine, water Pelton turbine), conduct measurements of full scale biomass system (boiler with storage unit), hydrogen systems with fuel cells.

Admission requirements:
General knowledge of physics and mathematics. Ability to perform laboratory measurements, general knowledge of measurement techniques and basics of data processing.

Bibliography

1. **Handbook of energy efficiency and renewable energy, edited by F. Kreith, D. Yogi Goswani, CRC Press, 2007**
2. **B. Sorensen, Renewable energy conversion, transmission and storage, Academic Press, 2007**

V. Quaschning, Understanding Renewable Energy Systems, Earthscan, 2005

Assessment:

Laboratory evaluation and test.