CARBON DIOXIDE MITIGATION TECHNOLOGIES
(4 ECTS**)** ***Compulsory***

Responsible person:
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Learning outcomes:

The course is aimed at:

- getting students acquainted with the major carbon dioxide capture technologies related to fossil fuel based power plants (pulverized/fluidized bed coal combustion - post combustion capture; integrated gasification combined cycle - precombustion capture; pulverised/fluidized bed oxyfuel combustion) including process engineering analysis.
- developing understanding of physical processes and chemical reactions involved in carbon capture dioxide capture, particularly by absorption and adsorption, enhancing modelling skill of absorption providing basic knowledge of thermodynamics and kinetics.
- enabling students to prepare the process design of carbon dioxide emission and capture for industrial operation of coking plant, power plants and chemical plant. The student should 1) get the knowledge of methods leading to the reduction of CO_2 emissions – the methods of CO_2 capture and sequestration, as well as possibilities of chemical utilization of carbon dioxide; 2) be able to discuss the advantages and disadvantages of methods of CO_2 emission reduction; 3) propose the method of CO_2 utilization.

Course main content:

The course is built of two parts: lectures (15 h) and project (30 h)

Lectures:

Lectures**:** Options of CO_2 reduction. The methods of CO_2 capture. CO_2 transport and storage. Dangers of storage. Direct and indirect industrial utilization of carbon dioxide. New technologies of CO_2 chemical utilization under study.
The content of lectures:
World needs to develop a balanced portfolio of energy generation mix that will address climate change concerns. The knowledge of "climate portfolio" needs to be developed by better understanding the science and the potential impacts, developing technological responses for adaptation and mitigation, and formulating policies that take into account the economic costs. The purpose of this course is to discuss an important opportunity which we should consider as part of technological response, namely the capture and sequestration of CO2 from large stationary sources. We will first discuss the motivation for developing CO2 capture and sequestration technologies and then provide some background information, looking at both the history and economics of this mitigation option. Next, we review the major technological components - capture technology, geological storage,, and direct utilization. An important issue of system integration will be provided including economy of energy generation. Particular attention will be paid to carbon dioxide direct utilization in chemical processes. Carbon dioxide is considered to be main challenge for power generation as well as for any other industrial application of coal. Poland's energy sector is primarily based on coal combustion that covers almost 96% of demand. Future development of that sector depends on the restriction on carbon dioxide emission or trading value of allowances. There are tree main technological approaches to the development of new coal based generation capacity, namely:

- Air blown combustion and carbon dioxide separation from flue gases by chemical absorption.
- Oxy – combustion of coal and separation of carbon dioxide by water vapors condensation.
- Gasification of coal and carbon dioxide separation by physical absorption.

The fossil fuel power plants development strategy and technologies will be evaluated including: Options of CO_2 reduction. The methods of separation of CO_2 from combustion gases - the state-of-art and emerging technologies: chemical absorption, physical absorption, adsorption, cryogenic separation, membrane methods. Industrial examples of coal-fired plants with CO_2 capture. CO_2 transport. CO_2 storage: maturity of technologies. Dangers of storage. Direct and indirect industrial utilization of carbon dioxide. New technologies of CO_2 chemical utilization under study.

***Projects*:** students will be provided with related papers and books on the subject. students will be required to prepare and deliver process design of basic carbon capture technologies integrated with energy generation technologies or technologies used for chemicals production or coking.

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Projects – content:

Projects:

1. Post - combustion technological concept of carbon dioxide capture; efficiency penalty; energy generation cost
2. Pre - combustion technological concept of carbon dioxide capture; efficiency penalty; energy generation cost
3. Oxy - combustion technological concept of carbon dioxide capture; efficiency penalty; energy generation cost
4. Chemical use of carbon dioxide - polygeneration of energy and chemicals
5. Carbon footprint of other coal conversion processes

Admission requirements:

The basics of chemistry, and physical chemistry

Literature:

1. M. Sciazko et al., Uwarunkowania wdrożenia zero-emisyjnych technologii weglowych w energetyce, Wyd. IChPW, Zabrze 2007.
2. Raporty Europejskiej Platformy Zeroemisyjnej (www.zeroemissionplatform.eu)
3. DOE Reports (www.netl.doe.gov)
4. Carbon Capture Global Institute (www.globalccsinstitute)

Assessment:

Lecture: final course grade (from 2/fail to 5/very good)

Project: grade (from 2/fail to 5/very good)

Rules of final credit: The final course grade is based on the result of the exam (50 %) and the passing grade from the project (50 %).