

Carbon Capture, Utilization, and Storage

As the interest in carbon capture, utilization and storage (CCUS) continues to grow around the world, so does the need for qualified professionals with unique faculty to take on the challenge. Mines' CCUS graduate certificate program fills that need. By bringing together our world-renowned knowledge in the earth sciences, engineering and economics and business fields, the CCUS program enables students to explore the unique challenges around carbon sequestration, climate change and the energy transition while acquiring the skills needed to advance their career.

Requirements to obtain a Certificate in CCUS: Complete the Climate Change **and** the Energy Transition courses along with *either* the Geologic Storage *or* the Capture and Utilization courses.

Degrees Offered

- Graduate Certificate in Carbon Capture, Utilization, and Storage

Program description

The online CCUS certificate program is designed specifically for those wishing to strengthen their skills and deepen their knowledge base on Carbon Capture, Utilization, and Storage. Students can take the prescribed three courses to gain a Graduate Certificate in CCUS. All four courses can also be taken to count towards a graduate degree. The courses are online, of 8-week duration, and fully asynchronous.

Participants in this program can expect to:

- Assess data on climate change, and the effects of greenhouse gases on climate.
- Develop a solid foundation and proficiency in methods employed for the three aspects of carbon capture, utilization and storage.
- Learn workflow and practices in the industry. Assess efficiency of CCUS practices.
- Develop skills to better communicate with colleagues in other disciplines in the organization.
- Learn and understand fundamental concepts from well-known faculty, experienced in the field.

Options to Begin Program

Students must start the CCUS Certificate program with the Climate Change course or the Energy Transition course. Currently, the Climate Change is offered in First Online Session of Fall Semester and the Energy Transition course is offered in First Online Session of Spring Semester.

Examples of start dates and durations of the certificate program:

Fall Start in mid-August:

1. Climate Change Course: mid-August to mid-October
2. CCUS course 1 (Geologic Storage or Carbon Capture): mid- October to mid-December
3. Energy Transition course: mid-January to mid-March
4. *Optional: CCUS course 2 (Geologic Storage or Carbon Capture): mid-March to mid-May*

Spring Start in mid-January:

1. Energy Transition course: mid-January to mid-March
2. Optional: CCUS course 1 (Geologic Storage or Carbon Capture): mid-March to mid-May
3. Climate Change Course: mid-August to mid-October
4. *CCUS course 2 (Geologic Storage or Carbon Capture): mid- October to mid-December*

PROGRAM DIRECTOR AND PROFESSOR

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COURSE COORDINATORS AND PROFESSORS

1. SYGN520: Climate Change and Sustainability: **Manika Prasad**
2. EBG598D: Political Economy of the Energy Transition: **Ian Lange**
3. GPGN598AB: Geological Carbon Capture, Utilization, and Sequestration: **Ali Tura**
4. SYGN598C: Carbon Reduction: Capture and Utilization: **Anuj Chauhan**

Carbon Capture, Utilization, and Storage

The Mines graduate certificate in Carbon Capture Utilization and Storage (CCUS) is a three-course, 9 credit, online program that provides graduate-level learning opportunities in climate and societal impacts of elevated levels of atmospheric CO₂, quantitative assessment methods of CO₂ mitigation, as well as economic and policy analysis of a CCUS economy. By bringing salient aspects of CCUS under one umbrella, students gain and develop the knowledge and expertise to make informed decisions on CO₂ mitigation strategies, technologies, and can guide company and/or government policy and economic decisions.

The CCUS certificate program provides students with engaging learning experiences to understand and guide science-based discussions around climate change and how to assess it using environmental data and modeling methods; explore CO₂ capture and utilization technologies, and assess geologic utilization and sub-surface storage options. The program equips students with scientific knowledge about each CCUS topic and various technical CO₂ mitigation solutions and their risks. The program combines the expertise from our world-renowned graduate programs in Earth Sciences, Engineering, and Economics and Business and distills them into a certificate program on CCUS technologies and CCUS economy. This program is designed for professionals and recent graduates who want to acquire new skills for career advancement or get a head start on an advanced graduate degree. Courses in the program focus on real-world and current challenges and progress in CCUS techniques, and CCUS economics. The certificate program requires three 3-credit graduate courses identified below: two required courses and the option to choose an elective in either geologic or non-geologic CCUS.

Required Courses

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| CCUS520 | CLIMATE CHANGE AND SUSTAINABILITY | 3.0 |
| EBGN598 | POLITICAL ECONOMY OF THE ENERGY TRANSITION | 3.0 |

Elective Course

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| CCUS521 | GEOLOGICAL CARBON CAPTURE UTILIZATION AND SEQUESTRATION (CCUS) | 3.0 |
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OR

SYGN598C CARBON REDUCTION: CAPTURE & UTILIZATION 3.0

Course Modality:

All courses are virtual and asynchronous - so students can listen to the lectures at convenience. All material is online and recorded for offline review. There are timed discussions and deliverables each week where students interact with their peers and with the instructors. The office hours are at specific times, but specific times to meet outside of those hours are often arranged depending on schedule conflicts or on geographic locations.

CCUS520. CLIMATE CHANGE AND SUSTAINABILITY. 3.0 Semester Hrs.

This eight-week online course is intended to introduce students to effects of atmospheric CO₂ on climate, CO₂ mitigation and avoidance strategies, and aspects of ESG when considering mitigation strategies. The course will provide students with much needed working knowledge about effects of Greenhouse Gases (GHGs) using data, and models. It provides cause and effects of GHGs as well as potential solutions that are equitable and sustainable.

CCUS521. GEOLOGICAL CARBON CAPTURE UTILIZATION AND SEQUESTRATION (CCUS). 3.0 Semester Hrs.

This course will cover sub-surface aspects of sustainable CCUS projects. Specifically, the topics covered will be geology of the subsurface appropriate for CCUS, how to create sustainable projects, the physics of CO₂ transport, injection and storage it's their modeling studies, practical aspects of CO₂ flooding, monitoring and verification methods including seismic, gravity and electromagnetic methods, and assessing CO₂ capacity and migration. Each week of the course is taught by experts in the area from geology to engineering to geophysics and covers essential topics such as Class VI CCUS wells and EPA permitting, sustainable project development, to detailed physics such as CO₂ phase and flow in the subsurface.

EBGN598. POLITICAL ECONOMY OF THE ENERGY TRANSITION. 3.0 Semester Hrs.

This course provides an overview of economics, business, and political topics that are commonly found in the energy transition. Many of the assignments relate back to skills that are needed to interact with economics, business, and policy professionals. The course is designed for students with little, if any, social science or business training. Students will build a basic knowledge of economics, finance, and business issues that are relevant to energy markets and industries.

SYGN598. CARBON REDUCTION: CAPTURE & UTILIZATION. 3.0 Semester Hrs.

This course provides an overview of the technologies used for decarbonization with an introduction to the chemistry of the molecule and the reactive CO₂ capture technologies, carbon capture and separation technologies, thermodynamics, and practical applications from a CCUS systems development perspective.