



**CCS IN THE ACADEMIC COMMUNITY TASK FORCE
CARBON SEQUESTRATION LEADERSHIP FORUM**

Baseline Survey

*Mechanisms for International CCS Academic Collaborations,
Key Research Groups, Summer Schools and Networks*

May 2017

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1 Baseline Survey of Mechanisms for International Collaboration and Key CCS Academic Research Groups, Summer Schools and Networks

The following provides an initial baseline survey of mechanisms for international collaboration and key CCS academic research groups, summer schools, and networks for Academic Task Force members. The Task Force will complete survey information for all CSLF member countries by the CSLF Mid-Year Meeting in 2016.

1.1 United States (Academic Task Force Co-Chair)

The U.S. Department of Energy (DOE), Office of Fossil Energy manages its CCS RD&D under the Clean Coal Research Program, which is implemented jointly by the Office of Fossil Energy and the National Energy Technology Laboratory (NETL). Both organizations engage in international collaborative activities through formal agreements and informal arrangements such as dialogues or memorandum of understandings (MOUs). NETL also conducts onsite CCS research with universities and the private sector and hosts international researchers and visiting scientists. Additionally, international collaborative activities may be conducted under other instruments such as a contract, grant or other cooperative agreements, Cooperative Research and Development Agreement (CRADA), or Work-for-Others. DOE CCS funding opportunity announcements (FOAs) require prime recipients to be incorporated in the US; however, a foreign entity may receive funding as a sub-recipient. In addition to DOE, the National Science Foundation has supported international CCS research collaborations and student exchanges under various program areas.

Key University Research Programs

1.1.1 Carnegie Mellon University, Department of Engineering and Public Policy, Energy and Environmental Systems

The [Energy and Environmental Systems](#) group at Carnegie Mellon University's (CMU) Department of Engineering and Public Policy ([EPP](#)) has pioneered the development of the Integrated Environmental Control Model ([IECM](#)), a stochastic simulation model used worldwide to design and evaluate cost-effective emission control systems for fossil-fuel power plants, including advanced processes for CCS. CMU is also a leader in the arena of CCS public policy with research on technology innovation and the relationship between regulation and technology development. CUM's EPP is also member of the [CCS Regulatory Project](#).

Contact: Dr. Edward S. Rubin, Professor, Engineering & Public Policy, and Alumni Chair Professor, Environmental Engineering and Sciences– (412) 268-5897 or rubin@cmu.edu

1.1.2 Columbia University, Park Group

The [Park Group](#) at Columbia University's [Lenfest Center for Sustainable Energy](#) in the Earth Institute is leading a worldwide multidisciplinary [CCUS Research Coordination Network](#) (RCN) and supports the CCUS summer school, Research Experience in Carbon Sequestration ([RECS](#)). Park Group also conducts a number of research activities including: fundamental studies of novel organic-inorganic hybrid nanomaterials for application in carbon capture and conversion; tailored

synthesis of engineered carbon-neutral filler materials; in-situ and ex-situ carbon mineralization and production of hydrogen and liquid fuels from biomass and solid municipal wastes with integrated carbon sequestration.

Contact: Dr. Ah-Hyung (Alissa) Park, Interim Director of Lenfest Center for Sustainable Energy, The Earth Institute, Columbia University and Co-Principal Investigator, Research Coordination Network on Carbon Capture, Utilization and Storage – (212) 854-8989 or ap2622@columbia.edu

1.1.3 University of Illinois, Prairie Research Institute - Illinois State Geological Survey, Illinois Sustainability Technology Center

The Illinois State Geological Survey's (ISGS) and Illinois Sustainability Technology Center (ISTC) have an integrated approach to the full CCUS value chain through programs:

- Midwest Geological Sequestration Partnership (MGSC): Established in 2003, MGSC is one of seven regional partnerships operating under the U.S. DOE NETL Regional Carbon Sequestration Partnership Program. MGSC is conducting the Illinois Basin – Decatur Project, a large-scale deep saline one million tonne carbon storage project. PCOR is currently planning two commercial-scale CO₂ storage projects over the next few years that will inject 1 million tons of CO₂ per year.
- Sequestration Training and Education Program (STEP): Established in 2009, STEP is a knowledge sharing and capacity building center that conducts workshops, summer schools, knowledge sharing events, and capacity study tours to facilitate the dissemination of CCS knowledge and provide training for an emerging CCS industry
- The ISTC and ISGS Applied Research Laboratory conduct bench-scale and pilot-scale demonstration to test selected separation and capture technologies for fossil fuel- and biomass-fired systems.

Contact: Sallie Greenberg, Associate Director for Energy Research & Development - (217) 244-4068 or sallieg@illinois.edu

1.1.4 University of Kentucky, Center for Applied Energy Research

The [PowerGen Research](#) group at the University of Kentucky's Center for Applied Energy Research (CAER) works in a number of CCS research areas including: post-combustion CO₂ capture (heat-integrated amine and ammonia scrubbing); oxyfuel combustion through chemical looping combustion for solid fuels; green power production via biomass utilization (co-firing, biomass liquefaction, and biodiesel by-product glycerine combustion); and plant performance improvement and process optimization. The University of Kentucky is also a member of the [US-China Clean Energy Center](#).

Contact: Dr. Kunlei Liu, Associate Director for Research, CAER – (859) 257-0293 or kunlei.liu@uky.edu

1.1.5 University of North Dakota, Energy & Environmental Research Center, Center for Climate Change & Carbon Capture and Storage

The Energy & Environmental Research Center's (EERC) [Center for Climate Change & Carbon Capture and Storage](#) has two major CCS programs:

- Plains CO₂ Reduction ([PCOR](#)) Partnership: Established in 2003, PCOR is one of seven regional partnerships operating under the U.S. DOE NETL Regional Carbon Sequestration Partnership Program. PCOR is currently planning two commercial-scale CO₂ storage projects over the next few years that will inject 1 million tons of CO₂ per year.
- Partnership for CO₂ Capture ([PCO₂C](#)) Technology Development: PCO₂C is currently conducting a pilot-scale demonstration to test selected separation and capture technologies for fossil fuel- and biomass-fired systems.

Contact: John Harju, Associate Director for Research - (201) 777-5157 or jharju@undeerc.org

1.1.6 The University of Texas at Austin, Gulf Coast Carbon Center

The Gulf Coast Carbon Center ([GCCC](#)) has a portfolio of seven major field research projects focused on technologies to monitor subsurface CO₂ storage. GCCC has also led a number of projects on storage capacity estimates, EOR screening, economic assessments, leakage risks to water resources, pressure assessments, and CCUS systems integration. GCCC hosts [STORE](#), a new training and education effort.

Contact: Dr. Susan D. Hovorka, GCCC Principal Investigator and Senior Research Scientist at The University of Texas at Austin Bureau of Economic Geology – (512) 471-4863 or susan.hovorka@beg.utexas.edu

1.1.7 The University of Texas at Austin, Luminant Carbon Management Program

Founded in 2007, the [Luminant Carbon Management Program](#) at the Rochelle Lab offers PhD candidates at the university opportunities to conduct research on carbon capture from coal and natural gas power plants with a focus on amine scrubbing. There are currently 16 graduate students working on collecting thermodynamic and rate measurements, testing amine degradation, mitigating nitrosamines, quantifying aerosol formation, creating process models, improving process design and efficiency, and understanding pilot plant results.

Contact: Dr. Gary T. Rochelle, Carol and Henry Groppe Professor in Chemical Engineering, Department of Chemical Engineering– (512) 471-7230 or gtr@che.utexas.edu

1.1.8 Stanford University

The Global Climate & Energy Project ([GCEP](#)) develops and manages a portfolio of CCS research programs that is a part of the [Carbon-Based Energy Systems](#) research group including: carbon capture systems analysis; carbon-based sorbents for selective CO₂ capture; new materials and processes for energy-efficient carbon capture; novel ionic liquids for pre-combustion CO₂ capture, and multiphase flow of CO₂ and water in reservoir rocks. GCEP also has a number of [external collaborations](#) with leading CCS academic research groups around the world.

Contact: Dr. Sally Benson, Director, GCEP – (650) 725-0358 or smbenson@stanford.edu

The Stanford Center for Carbon Storage ([SCCS](#)) in the Department of Energy Resources Engineering focuses on CO₂ storage in saline aquifers, shale and coal formations, and mature or depleted oil and gas reservoirs and addresses critical questions related to flow physics and chemistry, simulation of the transport and fate of CO₂ in geologic media, rock physics, geophysical monitoring, and geomechanics.

Contact: Dr. Anshul Agarwal, Executive Director, SCCS, Stanford University - anshula@stanford.edu

1.1.9 West Virginia University, Energy Institute

West Virginia University's (WVU) [Energy Institute](#) coordinates University-wide energy research in engineering, science, technology and policy. It also facilitates domestic and international partnerships. Under the Energy Institute, WVU's National Research Center for Coal and Energy ([NRCCE](#)) has a broad [CCUS](#) portfolio and is a member of a number research networks including the Advanced Virtual Energy Simulation Training and Research ([AVESTAR](#)), and the Zero Emissions Research and Technology ([ZERT](#)) focusing on understanding the basic science of underground geologic CO₂ storage. The Energy Institute also leads the US-China Clean Energy Research Center's Advanced Coal Technology Consortium ([CERC-ACTC](#)) and coordinates US and China joint CCUS research with other universities including the University of Wyoming and University of Kentucky.

Contact: Dr. Brian J. Anderson, Director, Energy Institute, (304) 293-0823; Dr. Richard Bajura, Director, National Research Center for Coal and Energy, (304) 293-6034 or Richard.Bajura@mail.wvu.edu

Summer Schools

1.1.10 Research Experience in Carbon Sequestration (RECS)

The Research Experience in Carbon Sequestration ([RECS](#)) is the premier US CCUS education and training experience and career network. Founded in 2004, with support from US DOE and recent sponsorship from the [CCUS-RCN](#), the intensive 10-day, interactive program combines classroom instruction with group exercises, over 10 CCUS site visits including the National Carbon Capture Center and the Kemper County Energy Facility, and hands-on field activities that cover the range of CCUS science, technology, policy, and business topics. The RECS network has over 400 alumni and 100 faculty that represent the nation's leading CCUS experts. The program is held annually in June for 30 people and is open to a limited number of international participants. RECS 2016 will be hosted by Southern Company in Birmingham, AL.

Contact: Pamela Tomski, Founder & Director, RECS – (202) 390-8896 or ptomski@mac.com

Research Networks

1.1.11 Research Coordination Network on Carbon Capture, Utilization and Storage

The Research Coordination Network on Carbon Capture, Utilization and Storage ([RCN-CCUS](#)) facilitates interdisciplinary research collaborations and training to develop new understanding, theories, models, technologies, and assessment tools for the CCUS field. Participating members include researchers in academia, national labs, young professionals, K-12 teachers, international partners and industrial members as well as the five Engineering Founder Societies (American Institute of Chemical Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers and the Institute of Electrical and Electronics Engineers).

Contact: Dr. Ah-Hyung (Alissa) Park, Columbia University – (212) 854-8989 or ap2622@columbia.edu; Dr. Darlene Schuster, Executive Director, Institute for Sustainability (an AIChE Technological Community) (410) 458-5870 or darls@aiche.org

1.1.12 Zero Emissions Research and Technology

The Zero Emission Research and Technology Center ([ZERT](#)) is a research collaborative led by Montana State University focused on understanding the basic science of underground (geologic) CO₂ storage and to develop technologies that can ensure the safety and reliability of that storage. ZERT is a partnership involving DOE laboratories (Los Alamos National Laboratory, Lawrence Berkeley National Laboratory, National Energy Technology Laboratory, Lawrence Livermore National Laboratory, and Pacific Northwest National Laboratory) as well as universities (Montana State University and West Virginia University)

Contact: Dr. Lee Spangler, ZERT Project Director, Montana State University – (406) 994-2891 or spangler@montana.edu

International Student Internships and Exchanges

1.1.13 US Department of Energy, Office of Fossil Energy

With funding support from partner countries, the US DOE, Office of Fossil Energy hosts international student interns that allow international participants to be stationed at DOE Headquarters in Washington, DC for a 6-8 week term. The internships are not conducted under a formalized DOE program rather they are partnerships with international groups who fund the position. The DOE offers a focus on various aspects of fossil energy scientific, technical and policy issues, including CCUS.

1.2 Mexico (Academic Task Force Co-Chair)

Since 2008, Mexico has undertaken a number of measures to develop and implement CCUS technologies. The Ministry of Energy of Mexico (SENER), Clean Technologies Direction manages CCUS activities throughout the country, which is guided by the [CCUS Technology Roadmap in Mexico](#). The Ministry of Environment and Natural Resources (SEMARNAT) is also engaged in CCUS. As part of SENER, the Sustainable Energy Fund supports national academic research and collaborations with stakeholders in Mexico. Other developments include the creation of a Mexico CCUS Center supported by The World Bank CCS Trust Fund and development of a CCUS Masters degree specialization at the National

Autonomous University of Mexico (UNAM) under a collaboration with Lawrence Berkley National Laboratory. The World Bank CCS Trust Fund is also supporting a number of enabling activities to advance Mexico's CCUS roadmap including legal, regulatory and public engagement frameworks. Mexico has undertaken a number of capacity development activities over the last few years to enhance understanding of CCUS, particular among the academic community. The Global CCS Institute, in partnership with SENER and with support from Asia Pacific Economic Cooperation (APEC), led these [activities](#).

1.3 Canada (Academic Task Force Member)

Governments in Canada fund CCS RD&D through a range of programs delivered by federal funding providers such as [Natural Resources Canada](#) (NRCan), [Sustainable Development Technology Canada](#), and the [National Research Council Canada](#), as well as through provincial programs, mainly in [Alberta](#) and [Saskatchewan](#). Also, the [Natural Sciences and Engineering Research Council of Canada](#) provides grants specifically for university-based research in the natural sciences and in engineering, which includes grants for academic CCS research. NRCan's Canmet ENERGY-Ottawa, one of Canada's national energy laboratories, conducts onsite [CCS research](#) in collaboration with universities and the private sector and hosts international researchers and visiting scientists, and facilitates NRCan scientists' visits to research facilities abroad. NRCan also engages in international collaborative activities in CCS through arrangements such as dialogues or MOUs.

Key University Research Programs

1.3.1 University of Calgary

The University of Calgary's [CREATE Training Program in Carbon Capture](#) provided a comprehensive training opportunity for students working on carbon capture technology. Working in coalition with energy research partners, the program trains students to develop various carbon capture technologies in every stage in the development of new carbon capture technologies across several themes, including pre-combustion capture, post combustion capture and biological capture. Researchers are being funded at the universities of [Calgary](#), [Alberta](#), [Ottawa](#), [Carleton](#) and [British Columbia](#), with additional collaborators from Canada and around the world, including [Cranfield University](#) in the UK, [CanmetENERGY Natural Resources Canada](#), and the [Canadian Clean Power Coalition](#).

Contact: George Shimizu- (403) 220-5347, gshimizu@ucalgary.ca

At the University of Calgary's [Schulich School of Engineering, Chemical and Petroleum Engineering, the Energy Innovations for Today and Tomorrow](#) research group is collaborating with industry to explore conventional and unconventional energy resources from the Arctic to the deep biosphere to find more efficient extraction methods as well as finding new resources, such as gas hydrates. They are making breakthroughs in renewable and alternative energy including solar energy conversion, fuel cells, and hydrogen and CO₂ capture and storage. Research activities include fluid flow and transport phenomena in porous media, CO₂ storage in geological media, and upscaling and parameter estimation.

Contact: Hassan Hassanzadeh, (403) 210-6645, hhassanz@ucalgary.ca

Researchers at the University of Calgary's [Gas Hydrates Laboratory](#) study gas hydrate thermodynamic properties and formation and decomposition kinetics using particle size analyzers. They develop numerical models to evaluate the viability of

using hydrate to sequester CO₂ and the potential of natural gas production from hydrates.

1.3.2 University of Alberta, Department of Civil and Environmental Engineering, School of Mining and Petroleum Engineering, Geotechnical Engineering

The research team at the University of Alberta's [Geomechanical Reservoir Experimental Facility](#) conducts research on resource recovery in unconventional hydrocarbon reservoirs and focuses on reservoir geomechanical behavior and its impact on resource recovery and operational risk. The team also investigates the utilization and storage of CO₂ with a focus on improving reservoir geomechanical understanding of the relationships between measured and modeled subsurface fluid flows spanning the range of spatial and temporal scales relevant to economic and environmentally sustainable resource management.

Contact: Rick Chalaturnyk- (780) 492 9992, rjchalaturnyk@ualberta.ca

1.3.3 Carleton University, Carleton Sustainable Energy Research Centre

The [Carleton Sustainable Energy Research Centre \(CSERC\)](#) conducts research in both engineering and policy related to the energy system (energy production, transportation and end-use) as well as all of the connections and outlining policies that encompass these three broad categories. Research under the Implementing Sustainable Energy Technology heading includes [Carbon Capture and Storage](#), which looks at the issues that decision-makers confront in encouraging the uptake of this technology and how to manage uncertainties and regulate risks.

Contact: James Meadowcroft- (613) 520-2600 x 2214, james_meadowcroft@carleton.ca

1.3.4 University of British Columbia

The University's of British Columbia's [Department of Chemical and Biological Engineering](#) conducts a wide range of energy research including carbon dioxide capture and removal, and waste water treatment, energy efficiency and analysis.

Contact: Peter Englezos, peter.englezos@ubc.ca

In the Department of Earth, Ocean and Atmospheric Science, the [Global Environmental Change](#) research group is focused on identifying and evaluating novel CO₂ storage pathways, selective adsorption of CO₂ and methane in coal seams, and approaches to accelerating carbonation reactions in mine residue.

Contact: Gregory Dipple, (604) 827-0653, gdipple@eos.ubc.ca

1.3.5 University of Regina

[Dr. Yongan Gu's research group](#) in the Faculty of Engineering and Applied Science, Petroleum Systems Engineering has four primary research areas: CO₂ EOR, solvent vapour extraction (VAPEX), asphaltene precipitation and deposition, and fluid phase behaviour and PVT studies. One of the groups major research interest CSS in depleted oil and gas reservoirs and saline aquifers.

Contact: Yongan (Peter) Gu, (306) 585-4630, peter.gu@uregina.ca

The [Clean Energy Technologies Research Institute \(CETRI\)](#) of the University of Regina is a research and demonstration institute that integrates clean energy and CO₂ capture research and undertakes broader thematic research to address challenges related to GHG mitigation and the development of alternative clean energy technologies. CETRI actively researches and demonstrates the possibilities of drastic improvements in CCS technologies, as well as methods for minimizing the costs associated with these technologies.

Contact: Raphael Idem (Director), (306) 585-4470, raphael.idem@uregina.ca

Research Networks

1.3.6 CMC Research Institutes

[CMC Research Institutes](#), hosted at the University of Calgary, is a neutral, independent, not-for-profit organization dedicated to accelerating innovation associated with addressing the challenge of industrial GHGs. CMC committed CAN\$22 million to 44 research projects in Canadian universities. This investment led to additional contributions and partners from more than 100 companies, stakeholder organizations and international universities. CMC is now building on this network of global researchers to engage with projects ready for field and pilot testing. CMC's [Carbon Capture and Conversion Institute \(CMC.CCCI\)](#), a collaboration with the University of British Columbia's Department of Chemical and Biological Engineering and its affiliated Clean Energy Research Centre, and BC Research Inc., accelerates the development, piloting, scale-up and validation of new carbon capture and conversion technologies. CMC's [Containment and Monitoring Institute \(CMC.CaMI\)](#), an affiliation between CMC and the University of Calgary, is focused on the detection and monitoring of subsurface fluids, including CO₂. A key part of CMC.CaMI is its [Field Research Station](#), which offers clients the opportunity to test and refine measurement, monitoring and verification technologies for subsurface storage of liquids, including CO₂.

Brian Mellor, Interim Managing Director, CMC Research Institutes-403-210-7767, brian.mellor@cmcgghg.com

1.4 Italy (CSLF Member)

1.4.1 Sulcis Summer School

The Sulcis Summer School on CCS, organized with the support of universities, research institutes and major companies in the sector, aims to offer to participants a broader view of all the possible issues that revolve around a theme of urgent relevance today, such as the reduction of carbon dioxide emissions into the atmosphere. It also provides information and documentation on all the technological sides of the CCS subject - including an update of ongoing projects worldwide.

Lessons are mixed with practical training in the "field". All registered students are enabled to access the e-learning platform of ENEA ICT Technical Unit (<http://elearning.enea.it>) where they can join a special learning program on CCS. The Sulcis Summer School is keen to provide training and information for administrators and stakeholders in order to increase confidence on CCS technologies and thereby contribute to their social acceptability.

1.5 Norway (CSLF Member)

Research, development and demonstration (RD&D) is a fundamental element of Norway's CCS policy.

1.4.1 Technology Centre Mongstad (TCM)

The Technology Centre Mongstad (TCM) is a facility for testing and improving CO₂ capture. Situated north of Bergen, it develops long-term and targeted testing and qualification of technologies for CO₂ capture since 2012. At TCM suppliers, in collaboration with the international research community, can test multiple capture technologies. Flue gas is currently available from two sources: a gas power plant and an oil refinery.

1.4.2 Climit

The government has since 2005 funded a large national programme for RD&D on technologies for capture, transport and storage of CO₂ from fossil-based power production and industry – CLIMIT. Administered by the Research Council of Norway (CLIMIT R&D) and Gassnova (CLIMIT Demo), CLIMIT funds research, innovation and technology development from basic research to pilots and demonstration. By 2017, it has funded more than 260 projects across the entire CCS value chain including power generation with CCS, CO₂ capture technologies, CO₂ compression, transport and storage and enhanced oil recovery with CO₂.

1.4.3 The Norwegian CCS Research Centre

The Norwegian CCS Research Centre was established in 2016. It is led by the R&D institute SINTEF and involves 15 industrial partners and 15 research partners. The Centre will run for eight years. NCCS is designed to enable fast-track CCS deployment through industry-driven science-based innovation, addressing the major barriers identified within demonstration and industry projects in Norway and Europe, aiming at becoming a world-leading CCS centre. NCCS will build on the FME BIGCCS, which has delivered top level innovations and significantly helped develop CCS between 2008 and 2016. The Research Council of Norway will provide funding.

1.4.4 European Carbon Dioxide Capture and Storage Laboratory Infrastructure

Norway is participating in ECCSEL, short for European Carbon dioxide Capture and Storage Laboratory infrastructure. The ECCSEL consortium teams up selected centres of excellence on CCS research from nine countries across Europe. The mission is to implement and operate a European distributed, integrated Research Infrastructure (RI) initially based on a selection of the best research facilities in Europe for CO₂ capture, storage and transport research. The NTNU – the Norwegian University of Science and Technology – is coordinating the project, with SINTEF as another Norwegian partner.

1.4.5 Accelerating CCS Technologies

Norway is participating in an EU ERA NET Cofund within CCS called ACT - Accelerating CCS Technologies as a new low-carbon energy vector. The Research Council of Norway is the Norwegian partner and is also coordinating the programme. A consortium with ten partners from nine countries was established in 2015.

1.6 Poland (Academic Task Force Member)

Over the past decade, Poland has been engaged with CCS research, development and demonstration as well as regulatory framework developments. In 2008, the Polish Ministry of Environment launched the National Programme, *Actions of the Ministry of Environment for assessment of formations and structures suitable for underground CO₂ geological storage*. In the same year, the Ministry of Economy initiated the Demo Clean Coal Program for Energy,

which includes CCS and runs through 2015. CCS is also included under the Ministry of Science's Strategic R&D Program under Advanced Technologies for Energy Generation. Poland's academic CCS R&D is funded from both the Ministry of Environment and the Ministry of Science and Higher Education. The [EU Framework Programme](#) and the Government of Norway through the [Polish-Norwegian Research Programme](#) also support CCS academic research in Poland.

Key University Research Programs

1.6.1 AGH University of Science and Technology

AGH University of Science and Technology is one of the leading institutes of technology and the largest technical university in Poland. CCS research focuses on geological carbon storage.

Contact: Dr. Stanislaw Nagy, Professor of Thermodynamics and Natural Gas Engineering, AGH University of Science and Technology

1.6.2 Częstochowa University of Technology

Częstochowa University of Technology is the largest and oldest institution of higher education in Częstochowa, Poland. Current CCS research includes: economically efficient and socially acceptable CCS/EOR processes, and innovative idea for combustion of solid fuels via chemical looping technology. In 2015, the university was a main organizer of the [1st International Conference & CCS Summer School](#) that focused on advanced CO₂ capture technologies.

1.6.3 Silesian University of Technology, Institute of Thermal Technology

The Silesian University of Technology (SUT) is one of Poland's largest technical universities and most of its CCS research is based out of the Institute of Thermal Technology (ITT). With strong links to Polish industry and local government, ITT focuses on energy systems analysis and has decades experience on clean coal technologies, including oxy-fuel combustion. ITT is a member of Optimisation of Oxygen-based CFBC Technology with CO₂ Capture ([O2GEN](#)), a European consortium that researches and demonstrates second generation oxyfuel combustion, and works on heat integration and plant optimization to minimize the energy penalty associated with CO₂ capture. ITT also has a current research project on [economically efficient and socially accepted CCS-EOR processes](#).

Contact: Dr. Marcin Liszka, Faculty of Power and Environmental Engineering, Institute of Thermal Technology, marcin.liszka@polsl.pl

International Student Internships and Exchanges

1.6.4 Krajowa Szkoła Administracji Publicznej (KSAP) / National School of Public Administration

Poland's National School of Public Administration trains students who after graduation take up positions in the central administration and may enter the Civil Service Corps or current Civil Service employees and Civil Servants who require continuing training. KASP graduates work at all levels of the Polish public administration in Poland and abroad. KASP funds an internship program with the US Department of Energy (DOE) for Polish student or Civil Servant to be stationed

at DOE Headquarters in Washington, DC for a 6-8 week term. The internship with DOE offers a focus on various aspects of fossil energy scientific, technical and policy issues, including CCUS.

1.7 Saudi Arabia (Academic Task Force Member)

Current CCS activities in Saudi Arabia are primarily focused on basic technical and policy research.

1.7.1 King Abdulaziz City for Science and Technology (KACST)

KACST is Saudi Arabia's national science agency and home to its advanced laboratories. Its duties extend from formulating and coordinating national science policies and plans to generous funding of scientific research programs. The Water & Energy Research Institute conducted and currently working on different CCS related research topics including pre and post combustion CO₂ capture, solar energy and photovoltaics, fuel cells, energy efficiency, CO₂ EOR and CO₂ subsurface storage and geophysical monitoring. The Materials Science Research Institute has research interests directed towards CO₂ capture and utilization. Lately KACST established with generous funds multiple local innovation centers and among these are the CCS Technology Innovation Center at King Fahad University of Petroleum and Minerals. Funds extend to multiple joint centers of excellence and among these of potential to CCS are the KACST-Cambridge university Center of Excellence for Advanced Materials & Manufacturing, KACST-UCLA Center of Excellence for Green Nanotechnologies, KACST-UC Berkeley Center of Excellence of Nanomaterials for Clean Energy Application and KACST- University of Oxford center of excellence for Petrochemicals. In addition, financial support are provided to different CCS projects conducted by various national universities and research centers through the National Science, Technology and Innovation Program.

1.7.2 King Fahd University of Petroleum & Minerals (KFUPM)

KFUPM is a leading Saudi university. Throughout its colleges and research centers various CCS related research are conducted including pre, post and oxy-fuel combustion, Electrochemical conversion of CO₂, mobile CO₂ capture using composite membranes, storage site assessments and monitoring, measurement and verification of CO₂ storage. To provide extreme support for research in areas of excellence, KFUPM has established Centers for Research Excellence and among those of interest are The KFUPM-MIT Collaboration Center on Clean Water and Clean Energy, The National Center of Research Excellence on Nanotechnology and The National Center of Research Excellence on Renewable Energy. Lately, In recognition of their research efforts, KACST established and supported their first CCS technology innovation center at KFUPM (KACST-TIC in Carbon Capture and Sequestration). The center mission is to find, develop and enhance the abilities of turning basic researches into new technologies in the CCS sector as well as the development of basic structure of education and research in that vital area.

1.7.3 King Abdullah University of Science and Technology (KAUST)

KAUST scientists are working heavily to address climate change issues through interdisciplinary approach by bringing experts together to find innovative, energy-efficient and cost-effective solutions. The different research centers through their graduate-level research programs covers vast CCS related technology areas including clean combustion technology, CO₂ catalytic conversion and utilization,

solar energy and photovoltaics, energy efficiency and cost effective and energy efficient capture of CO₂.

1.7.4 Saudi Aramco, and King Abdullah Petroleum Studies and Research Center (KAPSARC)

KAPSARC was established in 2008 as research and policy center directed towards energy and environmental exploration and analysis. Ongoing energy and environmental research includes the development of an overall framework through a first order assessment for a nationwide CCS program to motivate policy makers and companies to take action. This will include assessing the status of all ongoing CCS activities and programs (i.e. energy efficiency, reduced carbon emission, sustainable energy solutions and adaptation of new energy and environmental technologies) and developing the proposed CCS framework. KAPSARC collaborative approach that welcome the role and inputs of international scholars and organizations is believed to be the drive for global dialogue on energy and environment.

1.8 South Africa (Academic Task Force Member)

Research Networks

1.8.1 South African Centre for Carbon Capture and Storage

The South African Centre for Carbon Capture and Storage ([SACCCS](#)), established in 2009 as a division of the South African National Energy Development Institute (SANEDI), leads CCS activities in South Africa. The SACCCS undertakes CCS R&D and capacity building (both human and technical). The SACCCS is financially supported by the South African Government through SANEDI, the governments of Norway and South African industries, Sasol and Eskom. Current additional participants are the Anglo American, Xstrata Coal, Total, PetroSA, Agence Francaise de Developpement (AFD), Alstom, and Exxaro. Very few academic institutions are engaged in CCS research and SACCCS would like to see more attention and funding support to be given to increasing academic studies and research. In order to address these needs the Centre is supporting bursaries, student projects and is planning to support school projects. One project supported a scoping study on CO₂ mineralization by Dr. Frederic Doucet (CGS)

1.9 United Kingdom (Academic Task Force Member)

The UK has had a long term CCS research, development and innovation programme with projects totalling approximately £220M since 2011. Funding sources include the Department for Business, Energy and Industrial Strategy¹, the [Technology Strategy Board \(TSB\)](#), the [Energy Technologies Institute \(ETI\)](#) and the [Research Councils UK](#). It covers:

- £134million to support fundamental research and understanding
- £37million to support the development and demonstration of CCS components and next generation technologies (such as turbines or new solvents to capture the carbon dioxide)
- £53million for pilot scale projects to bridge the gap between research and commercial scale deployment

In total, over 100 separate projects have and are being funded through this programme.

¹ Successor department to Department of Energy and Climate Change (DECC)

Additionally, £2.5m has been made available to develop North Sea CO₂ storage. This new funding from DECC's Innovation Fund, was delivered by the Energy Technologies Institute (ETI) (<http://www.eti.co.uk/programmes/carbon-capture-storage/strategic-uk-ccs-storage-appraisal>)

The RCUK, which leads on academic research funding, will maintain funding of the CCS research as a proportion of the EPSRC portfolio over its current Delivery Plan period (2016-2020).

As part of this commitment the RCUK Energy Programme plans to

- Continue supporting the UK CCS Research Centre and CCS community
- Provide evidence using a whole-systems approach for developing and delivering an effective CCS strategy for efficient and significant impact. This includes working with the Economic and Social Research Council (ESRC) and Natural Environment Research Council (NERC).
- Ensure capacity and capability are available for the future of CCS by training and knowledge transfer via early-career and established-career fellowships.

Key University Research Programs

1.9.1 Imperial College London, Centre for Carbon Capture and Storage

The Imperial College Centre for Carbon Capture and Storage (IC4S), with links to the college's Energy Futures Laboratory and the Grantham Institute for Climate Change, researches all aspects of the CCS chain with an overarching systems approach that also includes analysis of legal and regulatory issues. Primary research areas include: solvent based capture; solid looping; oxyfuel; IGCC / hydrogen combustion; CO₂ reforming; carbon fuel cells; systems; power plant modelling and integration; CO₂ storage; policy and legal. (Contacts for researchers in for these areas, and more detail on their research, may be found here.)

Contact: Dr. Paul Fennell, Faculty of Engineering, Department of Chemical Engineering, Imperial College - +44 (0)20 7594 6637 or p.fennell@imperial.ac.uk

1.9.2 Scottish Carbon Capture & Storage

Founded in 2005, Scottish Carbon Capture & Storage ([SCCS](#)) is the UK's largest CCS research group and is a partnership of the British Geological Survey, University of Edinburgh and Heriot-Watt University working together with universities across Scotland. SCCS is funded by the Scottish Funding Council (SFC) and the Energy Technology Partnership (ETP) and works across all aspects of CCS from capture engineering and geoscience, to social perceptions and environmental impact, to law and petroleum economics. SCCS undertakes fundamental research and is available for consultancy. SCCS maintains a broad expertise and large portfolio of [research projects](#) across the CCS chain.

Contact: Various [SCCS team members](#) should be contacted based on area of interest.

1.9.3 University of Edinburgh, School of Engineering

The carbon capture group at the University of Edinburgh's School of Engineering is one of the largest in the UK that is involved in a large portfolio of [projects](#) with funding from the UK and a number of international partners. Their two main fields of

interest include adsorption and power plant engineering. The adsorption group's expertise covers: testing and ranking adsorbents for CO₂ capture using the zero-length column system; molecular modeling and simulation of novel nanoporous materials; dynamic process modeling and simulation of adsorption and membrane-based capture technologies; process integration and optimization; circulating fluidized beds and mixed-matrix membranes and carbon nanotubes. The power plant engineering group's expertise includes: power plant engineering with carbon capture; post-combustion capture for coal and natural gas, and oxyfuel combustion; process engineering, control and techno-economics of transient capture operations, and techno-economics of CO₂ capture and transport in low carbon electricity markets. The group, along with the University of Edinburgh's Schools of Geosciences, Engineering, and Chemistry, is also a member of the **Scottish Carbon Capture and Storage (SCCS) Centre**, the largest CCS grouping in the UK. The University of Edinburgh also offers a [Masters program in CCS](#) that is run in conjunction with the School of Engineering and School of Geosciences.

Contact: Prof Stefano Brandani, Institute of Materials and Processes, +44(0)131 6519030, S.Brandani@ed.ac.uk; Dr Mathieu Lucquiaud, Institute of Energy Systems, +44(0)131 6508697, M.Lucquiaud@ed.ac.uk

Research Networks

1.9.4 The UK CCS Research Centre

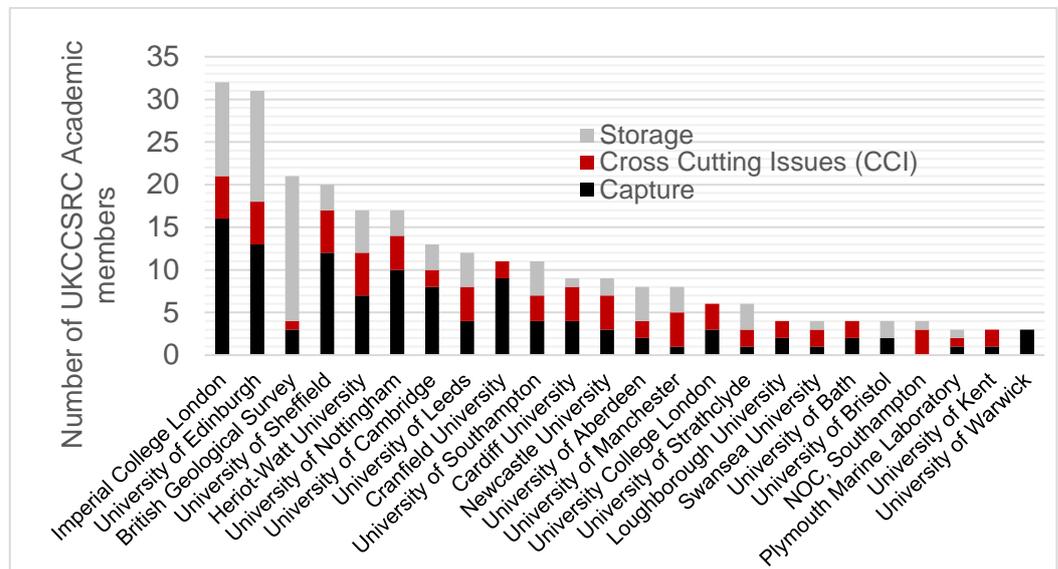
The UKCCSRC is based on six core institutions with complementary expertise:

- **British Geological Survey (BGS)** is a component institute of the Natural Environment Research Council, with a UK-wide remit for strategic and applied research and monitoring in the environmental sciences.
- **University of Cambridge (UoC)** is a world-leading university in Engineering and Technology (4th globally). The Cambridge Centre for Carbon Capture and Storage is part of the Energy@Cambridge strategic research initiative.
- **The University of Edinburgh (UoE)** is in the UK top 3 to 5 for research and technology innovation and is a founder member of Scottish Carbon Capture and Storage.
- **Imperial College London (ICL)** has one of the UK's largest CCS academic research programmes. ICL was recently ranked 8th in the world in the Times global rankings.
- **University of Nottingham (UoN)** is delivering a £15m energy and CCS research portfolio, including a Centre of Doctoral Training (CDT) in CCS.
- **University of Sheffield (UoS)** research focuses on Capture and Systems analysis. Sheffield hosts the UKCCSRC administration and also the main UKCCSRC Pilot-Scale Advanced CO₂ Capture Technology (PACT) national facilities (www.pact.ac.uk).

Investigators from five other partner institutions bringing their specialist knowledge to the UKCCSRC's core research programme: University of Manchester, Cranfield University, University of Strathclyde, Cardiff University, and University College London.

The UKCCSRC's wider coordination activities for UK academic CCS research includes 300 academics from 48 UK universities and academic research institutes with a further 250 Early Career Researchers. The 24 institutions with three or more academic members are shown below. The UKCCSRC also links to UK CCS industry, regulatory and other stakeholders through its Board and Independent Advisory Panel.

Contact: Prof Jon Gibbins, UKCCSRC Director and Professor of Power Plant Engineering and Carbon Capture, +44(0) 114 215 7235, j.gibbins@sheffield.ac.uk



1.10 IEAGHG Programme

Summer Schools

1.10.1 IEAGHG CCS Summer School

Established in 2009, the [IEAGHG CCS Summer School](#) is a one-week program that takes place in different countries around the world each year and includes presentations and discussion groups led by international CCS experts. In addition to the discussion programme, the students are divided into teams to undertake short research activities on issues of importance within the CCS area, with a presentation to their peers at the end of the week. Time is also allocated for networking and for informal discussions with the assembled experts. The program targets young scientists, e.g. PhD students with a background in engineering, geo-technologies, socio-economics. Generally some 60 students from both developed and developing countries participate in each programme. Over 20 experts from industry and research conduct lectures and lead discussion groups on various CCS topics.

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