



POLICY GROUP

CCS in the Academic Community: Key Recommendations on Academic Engagement

Background

At the June 2015 CSLF Mid-Year Meeting in Regina, the CCS in the Academic Community Task force was re-started with a near-term goal of identifying and engaging academic programs on CCS throughout the world.

In June 2016, the Task Force convened the first in-person meeting of the Academic Council on the margins of the CSLF Mid-Year Meeting in London. The meeting focused on four themes identified by the Task Force: Student Training and Practical Learning; Curriculum Development and Gap Analysis; Communications and Outreach; and Capacity Building. Presentations were delivered by representatives from the Academic Council in each of the four thematic areas, and broad discussions on these topics ensued. At the CSLF Policy Group Meeting in London, the group reported on the discussions of the Academic Council meeting and agreed to provide formal recommendations to the CSLF Policy Group at the Annual Meeting in Tokyo in October 2016. This document provides key recommendations for each of the four themes.

Action Requested

The Policy Group is requested to review the Key Recommendations document from the CCS in the Academic Community Task Force.



Key Recommendations on CSLF Academic Engagement **Report by the CSLF Academic Task Force** **October 2016**

I. Background

The academic community plays a vital role to advance carbon capture and storage (CCS) technologies¹ through research, development, and demonstration (RD&D), as well as through policy guidance and a wide range of educational programs that support development of the next generation of scientists, engineers and policymakers. Governments can strongly influence the extent to which the academic community is engaged in CCS. The Carbon Sequestration Leadership Forum (CSLF) is in a unique position to catalyze, grow and strengthen the academic community's contribution to achieving CSLF goals.

The mission of the *CCS in the Academic Community Task Force* (Academic Task Force), originally established in 2008, is to identify and engage academic programs on CCS throughout the world to help support the mission and path forward for the CSLF. Early accomplishments of the Task Force included a mapping and gap analysis of CCS post-graduate academic courses worldwide and links to the CSLF Capacity Building Task Force. Although in recent years this Task Force has been dormant, at the CSLF Mid-Year Policy Committee Meeting in Regina, Saskatchewan, Canada in June 2015, it was re-established with a new organizational structure and focus– to foster and support the CSLF mission and objectives via academic CCS research programs, international collaborations, research exchanges, networks, and summer schools. With more proactive engagement among the CCS academic community, the CSLF can facilitate international research collaborations in priority areas and leverage funding opportunities that advance the CSLF mission.

At the 2015 CSLF Ministerial, the Academic Task Force presented a *Baseline Survey and Plan of Action: Mechanisms for International Collaborations, Key Research Groups, Summer Schools and Networks* (Appendix 1) and secured endorsement from CSLF Ministers on the importance of the CCS academic community to help meet CSLF goals.

Following the Ministerial, the Academic Task Force established an Academic Council, comprised of representatives from institutes and universities in CSLF Member Countries, to serve in an advisory capacity to the Task Force, providing

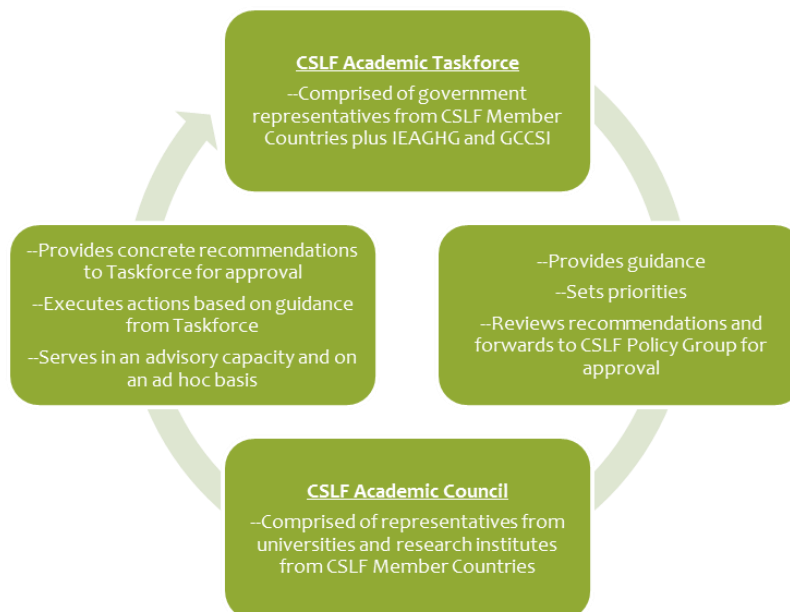
¹ CCS by definition includes carbon capture, utilization, and storage.



recommendations and acting on guidance received. The Task Force identified an initial set of priority areas for discussion with the Academic Council.

In June 2016, the CSLF Academic Task Force convened the first in-person meeting of the Academic Council on the margins of the CSLF Mid-Year Meeting in London. The meeting focused on four themes identified by the Task Force: Student Training and Practical Learning; Curriculum Development and Gap Analysis; Communications and Outreach; and Capacity Building. Presentations were delivered by representatives from the Academic Council in each of the four thematic areas, and broad discussions on these topics ensued. At the CSLF Policy Group Meeting in London, the group reported on the discussions of the Academic Council meeting and agreed to provide formal recommendations to the CSLF Policy Group at the Annual Meeting in Tokyo in October 2016.

Structure



II. Key Actions and Recommendations

In Task Force discussions following the Academic Council meeting, the group agreed to combine two themes and concentrate recommendations on: Student Training, Practical Learning, and Curriculum Development; Communications and Outreach; and Academic Community and Capacity Building.



Theme 1: Student Training, Practical Learning and Curriculum Development

Description: With the trending of Massive Open Online Courses and open access materials, accessibility to education has advanced and become enriched. While these types of technical platforms exist, there is not a clear grasp of what is available amongst the academics and industrial sectors of the CSLF Member Countries on materials for CCS training and curricula. This is an area academics can contribute in educating researchers, academics, industry and the public through sharing resources. Furthermore, well-organized, accessible resources can be leveraged towards capacity building in disseminating concepts, theory, and case studies in building the knowledge foundation in the CCS area. For example, the Province of British Columbia (B.C.) in Canada implemented the *B.C. Open Textbook Project* to increase access to higher education for students by providing openly licensed textbooks. This project focused on textbooks used in the top 40 highest-enrolled subject areas, with additions that followed. Projects such as these could offer CCS academics and programs to share resources more effectively, allowing students to access a wider selection of educational materials.

Thematic Goals

- *Organize course and curriculum on CCS for better exposure.*
- *Build a community of CCS educators.*
- *Create a network of CCS academics on the CSLF platform.*
- *Cultivate a community of educators in CCS through material sharing and regular meetings.*
- *More broadly publicize internship opportunities.*
- *Broaden opportunities for students in an international setting.*
- *Create a repository of material aimed at post-secondary education and professional training.*

In addition, CSLF nations can help to promote a forward thinking environment for CCS to grow by developing a framework for graduates in CCS related studies to spend time with appropriate government policy departments. Organizing and publicizing these can help to grow this sector internationally. Some internship programs may have citizenship, education, or age guidelines. There are several examples of existing internship programs that might be expanded or replicated in other countries. For example, the European Commission offers graduate traineeships across its whole remit (including energy and environment), and the International Energy Agency offers some internships to post-graduate students, which are managed through the Organisation for Economic Cooperation and Development. Additionally, the National School of Public Administration of Poland offers six-week internships for its students, including internships in other government agencies; the U.S. Department of Energy has hosted three Polish interns over the past three years, providing exposure to U.S. policy and



technical perspectives on CCS. Masdar Institute in the United Arab Emirates hosts the Young Future Energy Leaders Program, which seeks to educate, inspire, and position students and young professionals to become future leaders in the fields of alternative energy, by connecting them with today's leaders, offering internships and research opportunities, and facilitating energy-related site visits. The United Kingdom Parliamentary Office of Science and Technology and the Scottish Parliament Information Centre offer 3-month placements for Research Council UK (RCUK)-funded Ph.D. students and shorter internships for MSc students. Finally, many non-governmental organizations active in the energy-climate space host internships; two of the most high profile opportunities with some track record on CCS include Chatham House (United Kingdom), which has a large energy and climate program, and the World Resources Institute (United States and internationally). These programs could be models for other countries to consider and/or provide opportunities for international collaboration.

Additionally, providing students with opportunities for hands-on learning at CCS projects can enrich student learning and help build expertise in CCS. For example, the Mitacs Globalink Research Internship funds student research exchanges with an industrial focus (inwards and outwards) and accepts students on a rolling call. In addition, University of Regina has agreements with University of Edinburgh, University of Texas, Imperial College London, and University of Melbourne, which enable competitive internships for graduates from these universities at SaskPower. These programs, too, could be expanded or replicated to provide opportunities for students from around the world that are interested in pursuing careers in the CCS industry.

Recommendations:

- ❖ Update *Baseline Survey and Plan of Action* to include input from ALL CSLF Member Countries prior to the 2017 CSLF Mid-Year Meeting.
- ❖ Conduct a gap analysis on CCS post-graduate course mapping and summer school programs, leveraging ongoing work under the Trilateral CCS Initiative (Canada, Mexico, and the United States).²
- ❖ Identify existing modularized content for CCS knowledge sharing and education for broad dissemination and develop new modularized content, as needed.³

² The University of Regina has offered to fund \$7-10K for a graduate student to conduct the gap analysis.

³ The University of Calgary is working on a CCS course, and the University of Regina has a non-credit course on CCS that may be applicable. Carbon Management Canada (CMC) may also have training modules. The Academic Council will need to address licensing issues and the extent to which these entities are willing to share the training course materials. This may require setting up a system to allow content developers to collaborate through licensing (e.g., creative commons).



- ❖ Request CSLF Member Countries identify existing internships with applicability to CCS and provide information to the Secretariat prior to the 2017 CSLF Mid-Year Meeting.
- ❖ Request CSLF Member Countries' government organizations consider hosting interns to expose them to CCS policy and technical perspectives of the respective countries.
- ❖ Request CSLF stakeholder community to identify internship opportunities, with an emphasis on exposure to and/or hands-on experience at operational CCS sites.

Theme 2: Communications and Outreach

Thematic Goals

- *Broadly disseminate CCS activities and opportunities for the academic community.*
- *Create and maintain momentum through virtual meetings.*
- *Host public scholarship forum and activities.*
- *Broad publication of international student research*

Description: Postgraduate opportunities are currently piecemeal, and are often not well communicated outside of national or regional boundaries. While efforts to collaborate internationally are underway (e.g., Scottish CCS (SCCS) with Canada, University of California at Berkeley with the National Autonomous University of Mexico (UNAM)), there is not a 'one-stop' resource for storing and advertising postgraduate academic opportunities around the world.

Developing such a collaborative resource should see an increase in the level of collaboration, as contributors are kept up to date with active research in foreign institutes. In addition, ideally this would also lead to a greater degree of securing international collaborative funding for postgraduate studentships.

Additionally, several countries and regions have specific funding for industry, universities and research institutes to collaborate internationally. At times though, these programs would have greater impact if there was a way to synchronize and leverage available funding. By gathering and hosting these on the CSLF website, this would increase visibility for this type of funding, and encourage funding bodies to better synchronize suitable funding calls. Some examples of current student-focused funding announcements are included in Appendix 3.

Recommendations:

- ❖ Build website page under CSLF website on academic resources that includes links to:
 - outreach programs;
 - internship opportunity announcements;
 - summer schools and training programs on CCS;



- webinar announcements; and
- CCS modularized training.⁴
- ❖ Task and fund, where necessary, the Academic Council to identify and create content for website.
- ❖ Post videos from CSLF meetings and CCS workshops, in addition to relevant course materials for the meetings and workshops.
- ❖ Request CSLF Member Countries to provide information on their international funding opportunities for publication and broad dissemination via CSLF website on a routine basis.
- ❖ Request CSLF Member Countries' identify a point of contact for country-specific updates to the website.
- ❖ Post student research on CCS on the CSLF website.
- ❖ Enable academics to register as an academic (instead of a stakeholder) on the CSLF website.
- ❖ Fund an annual academics event based on *International CCS Academic Summit*.⁵

⁴ The CSLF Secretariat will need to consider how best to maintain the academic resources webpage as content may require routine updates.

⁵ The Academic Council should also seek to leverage Scottish CCS's extensive network, where possible.



Theme 3: Academic Community and Capacity Building

Description: CSLF Member Countries are leaders in CCS, and many are home to a variety of academic institutions, research and development, and industry. Several countries are also host to demonstrations, projects, and fully operational plants that showcase CCS technologies. For members of the public, these sites are examples of CCS in action. For researchers, academics, and industry, these sites offer the chance to observe and learn. Study tours of project sites and plants are a valuable resource where visitors can learn directly from plant operator and take this knowledge with them.

These tours would be especially beneficial for delegations or visitors from developing countries who may not have first-hand experience with CCS experts or projects. For those countries that are new to CCS or looking for ways to incorporate it into their energy and environmental portfolios, study tours can offer first-hand and practical knowledge and complement other capacity building efforts.

This is an area where the academic community can assist through organization and engagement efforts, as many host country academics will have ties with projects and plants. They may also be able to leverage academic networks, institutions, and resources that can facilitate these study tours for visitors. Study tours can be a helpful learning opportunity for those unfamiliar with CCS, especially those who may not have much exposure or access to the technology. Developing countries can benefit from these tours, as they offer tangible examples of the technology at work. With input and engagement from academics, industry professionals, and plant operators, study tours can act as a tool for outreach, awareness, and capacity building.

There are multiple countries that currently offer study tours on CCS. Australia has hosted various tours at power plants where CCS technologies are tested or used commercially, at projects such as Otway, and at research laboratories. Norway is home to established projects, such as the Sleipner CO₂ project, in operation since 1996, and ongoing research facilities such as the Technology Center Mongstad. The U.S. Research Experience in Carbon Sequestration (RECS) is a 10-day program offered to graduate and

Thematic Goals

- *Create learning opportunities for those unfamiliar with CCS.*
- *Improve outreach, awareness, and capacity building on CCS.*
- *Serve as a resource for capacity building activities and support the CSLF Capacity Building Programme, where relevant.*
- *Broad publication of international student research.*
- *Begin stakeholder engagement early and make public engagement a priority.*
- *Integrate stakeholder engagement into project management and regulatory processes.*
- *Build long-term stakeholder relationships.*
- *Make sufficient investment in time and resources.*
- *Understand and consult community.*
- *Maintain flexibility and diligence.*



doctoral students and early career professionals that includes classroom instruction and site visits. Site visits have included the National Carbon Capture Center, Plant Barry, and Kemper County Energy Facility. Located in Canada, the Boundary Dam Integrated CCS Project is the world's first commercial CCS project at a coal-fired power plant. Its operator, SaskPower, has created The Knowledge Center, through BHP Billiton's support of \$20 million over five years. This center aims to accelerate global CCS deployment by allowing the learnings acquired at Boundary Dam to be shared broadly, bringing down the costs of CCS, and managing development risk. Details on Canadian study tours are included in Appendix 4.

Stakeholder engagement is also widely recognized as a critical piece of the CCS value chain. Stakeholder engagement can be defined as a multi-directional process that brings together interested and impacted parties to discuss and implement activities that will potentially impact or influence the lives of a particular group of stakeholders. Indeed, a lack of stakeholder engagement, public awareness, and public support are often cited as major barriers to the development and implementation CCS projects and policy. At present, many CCS demonstration projects are conducted through partnerships between government, industry, non-governmental organizations, and academia. Demonstration projects and commercial projects coming online have several stakeholder groups, including general public, educators, government, regulators, industry, landowners, farmers, and others depending on specific circumstances. Each stakeholder may have varying interests, information needs, or concerns that need to be acknowledged and addressed. Additional detail is provided in Appendix 5.

Recommendations:

- ❖ Work with Capacity Building Governing Council on recommendations for capacity building moving forward.
- ❖ Request CSLF Member Countries to consider hosting study tours for developing countries (potentially outside of CSLF membership) with engagement and organization by the academic community.
- ❖ Evaluate CSLF Academic Council hosted webinars via CSLF for capacity building.
- ❖ Develop stakeholders' guidelines and engagement objectives document for use by CSLF Member Countries' Stakeholders.
- ❖ Create, evaluate, and refine stakeholder engagement strategy and communications plan.



Appendices

Appendix 1 – *Baseline Survey and Plan of Action: Mechanisms for International Collaborations, Key Research Groups, Summer Schools and Networks*

Appendix 2 – Readout of June 2016 Academic Council Meeting

Appendix 3 – Examples of current student-focused funding announcements

Appendix 4 – Details on Canadian study tours

Appendix 5 – Stakeholder Engagement



Appendix 1

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

Baseline Survey and Plan of Action

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

October 2015



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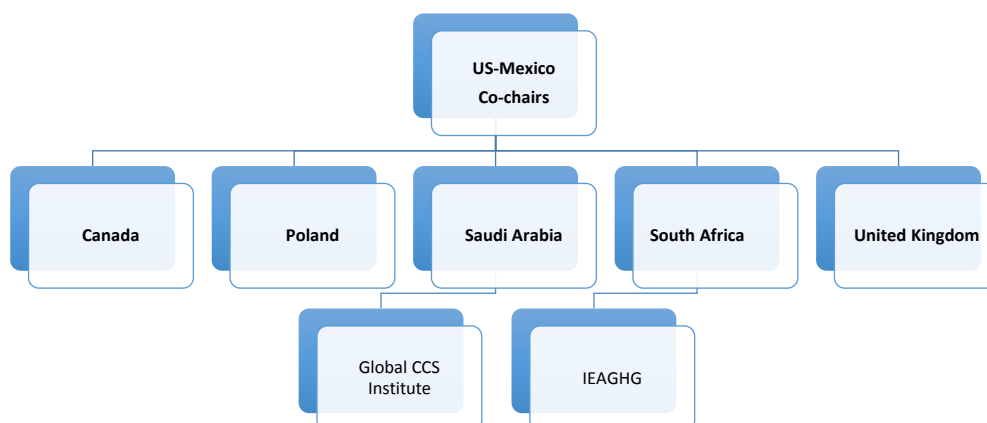
1 Introduction

The academic community plays a vital role to advance carbon capture and storage (CCS) technologies through research, development, and demonstration (RD&D), as well as through policy guidance and a wide range of educational programs that support development of the next generation of scientists, engineers and policymakers. Governments can strongly influence the extent to which the academic community is engaged in CCS. Thus, the Carbon Sequestration Leadership Forum (CSLF) is in a unique position to catalyze, grow and strengthen the academic community's contribution to achieving CSLF goals.

The mission of the *CCS in the Academic Community Task Force* (Academic Task Force), originally established in 2008, is to identify and engage academic programs on CCS throughout the world to help support the mission and path forward for the CSLF. Early accomplishments of the Task Force included a mapping and gap analysis of CCS post-graduate academic courses worldwide and links to the CSLF Capacity Building Task Force.

Although in recent years this Task Force has been dormant, at the CSLF Mid-Year Policy Committee Meeting in Regina, Saskatchewan, Canada in June 2015, it was re-established with a new organizational structure (Figure 1) and focus– to foster and support the CSLF mission and objectives via academic CCS research programs, international collaborations, research exchanges, networks, and summer schools. With more proactive engagement among the CCS academic community, the CSLF can facilitate international research collaborations in priority areas and leverage funding opportunities that advance the CSLF mission.

Figure 1: CSLF CCS in the Academic Community Task Force Members (June 2015)





Specifically, in re-establishing the Academic Task Force, its members agreed to take the following steps:

- Conduct a baseline survey of current CCS academic research programs, international collaborations, student exchanges, summer schools, and networks.
- Assess current funding commitments and mechanisms in CSLF member countries to support and enhance international CCS academic collaborations.
- Determine funding opportunities available from capacity development programs such as the World Bank CCS Trust Fund, Asian Development Bank CCS Trust Fund, CSLF Capacity Development Fund and other sources.
- Assess resource needs to strengthen and catalyse Academic Task Force activities and determine opportunities to leverage available funding.
- Outline a plan of action for the Academic Task Force to help achieve CSLF goals.

In response to the above agenda set forward by the new Task Force, this report provides an initial baseline survey of existing mechanisms for international CCS academic collaborations, key research groups, summer schools, and networks for Academic Task Force members. The report also includes key CCS academic contacts for Task Force members, and presents a Plan of Action to strengthen Academic Task Force activities, as summarized below. This report will soon be expanded to include all CSLF member countries.

1.1 Plan of Action: Key Highlights

- Secure endorsement from Ministers at the CSLF Ministerial Meeting in Saudi Arabia in November 2015 on the importance of the CCS academic community to help meet CSLF goals, and the new structure of the CCS in the Academic Task Force.
- Secure endorsement from Ministers at the November CSLF Ministerial Meeting to provide support for the Academic Task Force to host a planning workshop for the CCS academic community sometime in the first half of 2016, possibly in conjunction with the mid-year CSLF meeting. This Academic Task Force workshop will bring together academic representatives from the Task Force member countries, as well as other CSLF member states. The major objectives of the workshop are to:
 - Identify and document current academic community research linkages with CSLF Technical Group and Policy Group priorities;



- Determine where and how the CSLF can help leverage international collaborations, student exchanges, summer schools, networks and funding opportunities to further CSLF goals;
- Establish Academic Task Force membership across the global academic community, and
- Prepare an Action Plan for moving forward, to be presented at the CSLF 2016 Mid-Year Meeting.

Required support for this workshop includes basic travel expenses for up to 20 academic participants from CSLF member countries (and potential member countries) who would not otherwise be able to attend.

- In addition to the above, the Task Force will undertake the following activities:
 - Complete baseline survey for all CSLF Member Countries; where there is no current activity, determine possible mechanisms and opportunities.
 - Assess current CCS internship opportunities with governments and industry and how they may be expanded among CSLF member countries and linked to study-abroad programs.
 - Assess the availability of on-line CCS certification programs and CSLF member interest in providing such programs via the Academic Task Force.
 - Provide an on-line platform within the CSLF web site to include Academic Task Force information.



2 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.

2.1 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

2.1.1 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

2.1.2 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 [CCS Research Coordination Network](#) (RCN) and supports the CCS 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

2.1.3 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

2.1.4 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

2.1.5 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 CCS 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

2.1.6 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

2.1.7 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

2.1.8 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 [CCS](#) 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 CCS 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

2.1.9 Research Experience in Carbon Sequestration (RECS)

The Research Experience in Carbon Sequestration ([RECS](#)) is the premier US CCS education and training experience and career network. Founded in 2004, with support from US DOE and recent sponsorship from the [CCS-RCN](#), the intensive 10-day, interactive program combines classroom instruction with group exercises, over 10 CCS site visits including the National Carbon Capture Center and the Kemper County Energy Facility, and hands-on field activities that cover the range of CCS science, technology, policy, and business topics. The RECS network has over 400 alumni and 100 faculty that represent the nation's leading CCS 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

2.1.10 Research Coordination Network on Carbon Capture, Utilization and Storage

The Research Coordination Network on Carbon Capture, Utilization and Storage ([RCN-CCS](#)) facilitates interdisciplinary research collaborations and training to develop new understanding, theories, models, technologies, and assessment tools for the CCS 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

2.1.11 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

2.1.12 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 CCS.

2.2 Mexico (Academic Task Force Co-Chair)

Since 2008, Mexico has undertaken a number of measures to develop and implement CCS technologies. The Ministry of Energy of Mexico (SENER), Clean Technologies Direction manages CCS activities throughout the country, which is guided by the [CCS Technology Roadmap in Mexico](#). The Ministry of Environment and Natural Resources (SEMARNAT) is also engaged in CCS. 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 CCS Center supported by The World Bank CCS Trust Fund and development of a CCS Master's 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 CCS 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 CCS, 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](#).

2.3 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

2.3.1 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 analysers. They develop numerical models to evaluate the viability of using hydrate to sequester CO₂ and the potential of natural gas production from hydrates.

2.3.2 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

2.3.3 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

2.3.4 University of British Columbia

The University 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

2.3.5 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 CCCS 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

2.3.6 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.

Richard Adamson, President, CMC Research Institutes- 403-210-7767,
richard.adamson@cmcgghq.com

2.4 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

2.4.1 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

2.4.2 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.

2.4.3 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

2.4.4 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 CCS.

2.5 Saudi Arabia (Academic Task Force Member)

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

2.5.1 King Abdulaziz City for Science and Technology (KACST)

This initiative has funds allocated for supporting research on CCS through the KACST TIC on CCS (which is established in KFUPM). As well, KACST provides support of projects on CCS through the National Science, Technology and Innovation Program.

2.5.2 King Fahd University of Petroleum & Minerals (KFUPM)

The Technology Innovation Center for CCS at KFUPM received funding of US\$2.7 per year for a five-year period (2011-2015) with a research focus on oxy-fuel combustion, mobile capture, site assessments and monitoring, measurement and verification of CO₂ storage. Activities include new technology R&D and technology transfer, as well as training and education of both graduate and undergraduate students in the area of CCS. The Center also conducts conferences, symposia, and seminars, as well as offering short courses.

2.5.3 King Abdullah University of Science and Technology (KAUST)

The Clean Combustion Research Center, which is working toward a knowledge-based understanding of combustion phenomena, is establishing a graduate-level research program for the education and training of future experts in the area of clean combustion technology (including CCS).



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

Ongoing energy and environmental research at KAPSARC includes the development of an overall framework for a nationwide CCS program in the Kingdom of Saudi Arabia. This will include assessing the status of all ongoing CCS activities and programs and developing the proposed framework for CCS.

2.6 South Africa (Academic Task Force Member)

Research Networks

2.6.1 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 Development (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)

2.7 United Kingdom (Academic Task Force Member)

The UK has a four-year (2011-2015) £125 million cross-government CCS research, development and innovation programme. Funding comes from the Department of Energy and Climate Change (DECC), the [Technology Strategy Board \(TSB\)](#), the [Energy Technologies Institute \(ETI\)](#) and the Research Councils. It covers:

- £62million to support fundamental research and understanding
- £28million to support the development and demonstration of CCS components and next generation technologies (such as turbines or new solvents to capture the carbon dioxide)
- £35million for pilot scale projects to bridge the gap between research and commercial scale deployment

In total, over 100 separate [projects](#) are being funded through this programme.



Additionally, £2.5m has been made available to develop North Sea CO₂ storage. This new funding from DECC's Innovation Fund, will be delivered by the Energy Technologies Institute (ETI).

Key University Research Programs

2.7.1 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

2.7.2 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.

2.7.3 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 [Master's program in CCS](#) that is run in conjunction with the School of Engineering and School of Geosciences.

Contact: Dr. Jon Gibbins, Director & Principal Investigator, UKCCSRC and Professor of Power Plant Engineering and Carbon Capture, University of Edinburgh- +44(0) 131 650 4867, jon.gibbins@ed.ac.uk

Research Networks

2.7.4 The UK CCS Research Centre, University of Edinburgh

The UK CCS Research Centre ([UKCCSRC](#)) is a virtual network that coordinates all CCS academic research supported by the UK government, bringing together over [250 academics](#). The UKCCSRC is supported by the Engineering and Physical Sciences Research Council (EPSRC) as part of the Research Councils UK Energy Programme, with additional funding from the Department of Energy and Climate Change (DECC).

Contact: Dr. Jon Gibbins, Director & Principal Investigator, UKCCSRC and Professor of Power Plant Engineering and Carbon Capture, University of Edinburgh- +44(0) 131 650 4867, jon.gibbins@ed.ac.uk

2.8 IEAGHG Programme

Summer Schools

2.8.1 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

Carbon Sequestration Leadership Forum

www.cslforum.org



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.

Contact: Tim Dixon, tim.dixon@ieaghg.org



3 Leveraging Opportunities

3.1 CSLF Capacity Development Fund

The CSLF Capacity Building Fund was established in 2009 with funding from Australia, Canada, Norway and the United Kingdom to provide capacity building support to emerging economy CSLF members through projects such as workshops, study tours, technical training, and commissioned studies. The Fund's Governing Council has, to date, targeted Brazil, China, India, Mexico and South Africa for funding opportunities. All CSLF countries are eligible to apply for funding; however, the expectation is that the distribution of funding should focus on emerging economy members and represent a wide geographical spread. The following are examples of the types of capacity development activities the Fund has supported:

- workshops, presentations and seminars;
- site visits and study tours;
- practical training such as customized programs, site placements and secondments;
- roadmaps and analysis of issues;
- coaching and mentoring;
- establishing and facilitating networks between people, groups and organizations;
- education in the form of external or online courses, integration into university curriculums and research grants.

In 2015 the Governing Council approved the five projects in Brazil, China, India and Mexico and is currently accepting new project proposals.

Contact: Alice Gibson, Global CCS Institute, Alice.Gibson@globalccsinstitute.com

3.2 World Bank CCS Trust Fund

In November 2009, the World Bank CCS Trust Fund was established with contributions from the Government of Norway and the Global CCS Institute. The Norwegian Government has since provided two further contributions to the Fund along with the Government of the United Kingdom. The Fund supports early stage CCS activities such as legal and regulatory framework development, storage capacity assessments, and analysis of key issues and barriers. The Fund is moving towards support for pilot projects in developing countries with primary activity in China, South Africa and Mexico.



3.3 Asian Development Bank CCS Trust Fund



4 CSLF Academic Task Force Participants

United States (Co-Chair)

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Mexico (Co-Chair)

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Global CCS Institute

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Tim Dixon, Technical Program Manager, IEA Greenhouse Gas R&D Programme (IEAGHG):
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Academics

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University: rubin@andrew.cmu.edu | T: +1 412 268 5897



Appendix 2

Readout from June 2016 Academic Council Meeting

POLICY GROUP CCS in the Academic Community: Academic Council Meeting Readout

Background

At the June 2015 CSLF Mid-Year Meeting in Regina, the CCS in the Academic Community Task force was re-started with a near-term goal of identifying and engaging academic programs on CCS throughout the world. The task force was requested to provide a report summarizing its findings and recommendations, which was delivered at the 6th CSLF Ministerial Meeting in Riyadh. Members of the task force are Canada, Poland, Saudi Arabia, South Africa, the United Kingdom, the United States, and the Global CCS Institute. A meeting of this council was held at the CSLF Mid-Year Meeting in London on June 27, 2016. This readout is an overview of this meeting, and will provide background to the list of recommendations.

Action Requested

The Policy Group is requested to review the readout of the Academic Council meeting.



CSLF Mid-Year Meeting

Academic Council Meeting | June 27, 2016

Meeting Notes

Opening remarks and introductions

1. Host welcome
2. CSLF Academic Taskforce Overview
3. Readout from February International Academic Summit: Davey Fitch, Scottish SCCS
 - SCCS is the largest CCS research group in the UK (includes several universities, BGS)
 - Grouping of academia, industry, and government
 - Working to develop variety of international links
 - Publicize jobs/internships, funding opportunities, collaborations
 - Working with industry and public bodies
 - Held International Academic Summit in February 2016 in Edinburgh
 - Funding from NRCan, DECC, and CSLF Capacity Building Fund
 - Event was a forum for academics to progress institutional links in person
 - 18 academic institutes and 130 delegates in attendance
 - Formal MOU signed between University of Edinburgh and SaskPower
 - Produced output report following the meeting
 - Going forward: greater coordination in international funding opportunities, student mobility, and teaching internationalization
 - Goal: worldwide CCS and research network; wide buy-in globally
 - Next steps and actions similar to CSLF goals
 - Conclusions: lots of good will globally but busy academics
 - Someone needs to be responsible to drive it
 - Funding for research helps but better timeline, coordination needed
 - Need to avoid duplication of efforts and making the most of new ways of learning/communicating
 - May be time for an academic network
4. Meeting Expectations and Outcomes: Moderated by Jarad Daniels, U.S. DOE/CSLF Secretariat
 - Value added/relevance of group



- CSLF is good at engaging on policy—opportunity to coordinate data points and well positioned in global community
- Where can the Academic Council do the most good? How is it uniquely positioned?
 - Where is there a need/what can be the role?
 - How can we leverage and facilitate existing entities
- Development of academic materials globally?
- How do we communicate opportunities, efforts, etc.?
- Group: come up with deliverables, timelines, responsibilities
 - in time for next meeting—concrete plan (recommendations)
- important to identify individuals with specialist knowledge and coordinate effectively (may also need to consider funding incentives)
- Ed Rubin: critical part is financial and other resources
- There are no easy mechanisms currently for pooling funds

Session 1: Student Training and Practical Learnings on Carbon Capture and Storage

5. Summer Schools and Research Opportunities

a. Stephen Bryant

b. Tim Dixon, IEA Greenhouse Gas Programme

- IEA GHG summer school is well established and well linked
- Original rationale—shortage of education training in CCS; growing need for expertise and anticipated future employment level; level of student applications; host offers
- Consistently high level of applications and interest
- Many host offers, and strong sponsor support
- Objectives: improve CCS knowledgeable human resource
 - Educate young researchers in all CCS areas, broaden knowledge base, wider context
- Inspire young researchers to make careers in CCS
 - CCS awareness and global network of peers/contacts
- Accommodation and course funded by sponsors (travel is not covered)
- Curriculum: both technical and non-technical aspects
 - Updated throughout the year
- Group work with topics—research, collaboration, integration
- Alumni: 461 students from roughly 49 countries; around 25% from developing countries

6. Government Internships and Leadership Development: Mohammad Abu Zahra

- Masdar Institute in UAE
- Research university at a graduate level



- Focus: sustainable technology and clean energy
 - Work in collaboration with MIT
 - Government sponsors scholarships
 - Research and themes: clean energy, water use, sustainability
 - CCUS: area has 10-12 faculty members covering capture, storage monitoring, EOR, policy, and other areas
 - Sponsors and collaboration: some academic institutions, companies
 - Testing and evaluation of CO₂ capture and utilization (ESL)
 - Maersk: feasibility study of CCUS integrated, oxy-fuel
 - MIT: core research—development of new sorbents, system
 - Masdar/DOE project: led by RTI group; solid sorbent and suitable processes for post-combustion CO₂ capture
 - Other areas include CO₂ capture by chemical looping
 - YFEL: Young Future Energy Leaders
 - 1 year program—competitive application, funded
 - Launched in 2009; happens in tandem with Abu Dhabi Sustainability Week every January
 - Students from various majors
 - International students come from IT or STEM courses
 - Local young professionals in related fields
 - CCS program in development as part of YFEL
 - Other aspects: courses, workshops, international events, community service
7. Industry Hands-On Training and Opportunities
- a. Margot Hurlbert, University of Regina: (with input from Mike Monea)
- Experience with industry with SaskPower
 - Numerous industry partners, collaborations through project
 - New knowledge center set up between BHP Billiton and SaskPower
 - Test facility: will be used as a training center
 - There is a need to resolve issues at the Boundary Dam Project
 - SaskPower: will work with the University of Calgary, bring in academic institutions
 - Water, environment, clean energy research cluster exists
 - Global leadership in CCS and other clean energy activities is a focus
 - 4 of 9 Canadian research chairs work in climate and energy
 - 80 researchers are working in the climate cluster
 - University of Regina is home to a Greenhouse Gas Technology Center
 - Soon: research chair in power engineering will be set up



- There is a proposed center of excellence in CCUS
 - University of Regina would be a hub of research industries, industry, government, environmental NGOs, communities
- Vision of the center is to focus on engineering, research, technology development, as well as environmental impact, sustainability, public policy implications
- Why hands on training? Academics, industry, and students all benefit
- b. Mohamed Pourkashanian, University of Sheffield
 - Experience with the UKCCSRC
 - Focus on education, training, capacity building; aim to invest in highly skilled individuals
 - Universities involved include Cranfield, University of Edinburgh, Imperial College London, Leeds, Nottingham, and Sheffield
 - PACT facilities are involved
 - Specialist national facilities for research and development in advanced fossil energy, bioenergy, and CCS technology; pilot scale platform
 - Aim: support and catalyze industrial work
 - PACT sites/capability; plug and play facilities (ex: carbon capture plant)
 - PACT operational: partnership, collaborations, capacity building and skills
 - Partnership agreements in place
 - Two doctoral training centers—5 academics, 70 partner organizations
 - Also: CPD programs; industry training
 - Education: focus is on post-graduate training
 - Professional development training programs such as short courses, workshops, trainings
 - Development of collaborative training and capacity building in CCS, as well as capacity building and training in CCUS, such as summer schools
 - Aim to involve politicians and acquaint them with the technology
 - PACT is part of the International CCS Test Center Network
 - PACT 2—future capability review
- 8. Open discussion: Moderated by Vic Der, Global CCS Institute
 - Topics for discussion include effectiveness of student training, learning activities
 - Priority area of emphasis and focus going forward
 - CSLF can serve as a central repository of information
 - Is there a need for a more comprehensive program, for example among all summer schools?
 - Funding issues—these remain an obstacle
 - Strong recommendations will be made to the Policy Group
 - We need to leverage existing capabilities and come up with a path forward



- Need commitment to spend time and create an ask for Policy Group ministers
- What are some items worth doing, and what will it take?
- This meeting can help frame this ask, frame a proposal
- Need to prove cost effectiveness and other aspects
- CSLF: can act as a central repository for countries who don't have educational resources
- Government support is critical but academics need to champion this as well
- Is there a role for distance learning? Ex: UK Open University, Future Learning

Session 2: CCS Curriculum and Research Projects Development—Initial Gap Analysis

9. CCS Curriculum Development in Canada: Naoko Ellis, University of British Columbia

- Multidisciplinary and focused programs, courses can help; also, joint degree programs
- Example of Canadian program: 3 institutions plus the University of Calgary
 - 6 year course, distance course, 13 week course all exist
 - Various topics available
- University of British Columbia has a Clean Energy Research Centre and a graduate course on low carbon future
- Various disciplines are brought together under one course or program
- Field research station under Carbon Management Canada, other institutions
- New facility near Vancouver will offer training in this area
- There are possibilities to leverage technology and academic clusters
- Need to train, increase public awareness, support for public policy
- “Ideas to impact”—ties between academia and industry; process of research, translation, and implementation
- Gap analysis: very sparse; can leverage unique facilities and key institute activities/keep and build connectivity (bi-annual conferences); show a collective face to the world

10. CCS Curriculum Development in the United Kingdom: Colin Snape, University of Nottingham

- EPSRC (Engineering and Physical Sciences Research Council) hosts an engineering doctorate center
 - 4 year doctoral program across 2 centers
 - Over 100 doctoral students, 25 industrial partners
- UK is a focal point for training in the field, with strong links
- An advanced skills gap remains
- Effect of emissions legislation is also involved
- A large age gap remains among researchers (established professionals versus younger researchers entering the field)
- There are distinctive features of industrial doctorate center



- Students are fully engaged with industry
- Among distribution of projects, 40% go to CCS topics
- CO₂ capture, transport, storage, combustion, high temperature materials are all areas covered
- Training module remains varied: largely non-technical covering economic, business, policy aspects
- Public engagement is an ongoing training
- Summer school series exists: focused on the Far East
- Winter schools: this is a joint program with UKCCSRC – more economic
- The University of Nottingham hosts a campus in China
- Currently using CDT model to grow collaborative doctoral training internationally
- Taking broader approach to training—focusing beyond students

11. CCS Research Project Opportunities: Ed Rubin, Carnegie Mellon University

- History of collaborations, exchanges, and visits
- Examples of several students who did exchanges as part of exchange/collaboration programs
- These occurred as a result of several factors:
 - Personal relationships among faculty
 - Mostly on an ad hoc basis
 - Some were institutional programs designed to facilitate and support research collaborations (ex: UKCCSRC)
- CSLF: not doing as much as it should or could to support these activities
 - Made pitch to CSLF Policy Group at Riyadh meeting
- CSLF is in a good position to grow these activities
- Path forward should include identifying and linking academics and researchers with CSLF Technology and Policy Group plans and priorities
- Determine where and how CSLF and member countries can facilitate international collaborations and opportunities for exchanges that further goals
- There is a need to assess current funding commitment and mechanisms

12. CCS Research Opportunities in Norway: Arne Graue, University of Bergen

- Aim to make petroleum activities more sustainable
- Convert oil and gas industries into more sustainable/cleaner industries
- Need to increase coordination and collaboration among academics
- Public interest is there but not informed
- CCS leaders and researchers need to inform the public, rely on fact-based information
- Industry also needs to be on board



- Potential tax credits also need to be considered
- Norwegian experience—Petroleum School of Norway established; several MOUs exist
- NorTex Center: Norway and Texas utilizing experience in oil
- Similar collaborations need to be done on a larger scale
- CO₂-EOR is one way to make a profit
- Existing infrastructure, on-shore oil fields—these are advantages in Texas
- Collaboration: among 11 universities in 55 countries with funding
 - This is an example of the way forward

13. Open discussion: Moderated by Mohamed Pourkashanian, University of Sheffield

- How can we link and integrate activities together?
- Cost remains an important factor in academia
- Variation among countries in context and regulation on funding
- Suggestion: have an academic get involved in stakeholder group
- How can CSLF help to expand linkages, communicate out?
- One problem: younger faculty with fewer resources and assistance

Session 3: Communications and Outreach

14. Stakeholders Engagement within the U.S.: Sallie Greenberg, University of Illinois

- U.S. has the Regional Carbon Sequestration Partnerships—7 regional partnerships
- Primarily: function of a few organizations and parties
- Outreach working group has existed since phase 1
- These partnerships are specifically project based; focused on project based outcome
- Foundation work—best practices manual
 - A new addition will follow later this year
- World Resources Institute produced a report on stakeholder engagement
- Formal engagement processes should start very early in the life of a project
- RCSP has engagement recommendations
- What's needed: effective stakeholder guidelines and engagement objectives
- Activities happen around the who/what/how
- Stakeholders can be anyone: public, industry, government
- A project field site or another tangible item is helpful
- How do you turn a small amount of time into something impactful
- Engagement process needs to be spread across the project life cycle
- Uncertainty can be among geologic, sociological factors, others
- Research question and answer for science and society



- Similar concerns among industry/researchers, public
 - Recommendations to projects: do your homework, communicate frequently, establish relationships, know audience and topic, be prepared, listen, and respond
 - How do CSLF members interact and participate?
15. Engaging Industry on CCS: David Risk, St. Francis Xavier University
- Engagement is a limited “market space”
 - Few players, but many requests received
 - Industry gets tired of academics and pitches
 - There need to be mechanisms for alignment and collaboration: brokering, centers, open model
 - Some existing models exist: Carbon Management Canada, PTRC, IEAGHG
 - IEAGHG model: virtual think tank
 - Industry—IEAGHG equals classroom
 - Student: academic research opportunity
 - Researcher: collaborative project
 - Carbon Management Canada model—research provider, broker
 - Industry: gets problems examined/solved
 - Student: semi-embedded in environment
 - Researcher: gets involved in industry; experience
 - PTRC model: strategic research, deployment
 - Industry: builds strategic expertise; learns
 - Student: semi-embedded; management
 - Researcher: deployment of expertise
 - Individual partnership is one outcome
 - Solo research provider model:
 - Industry: solve a company specific issue
 - Student: embedded research; can commit to project, get mentors, experience, funding
 - CSLF model: depends on who, why, and the tie to industry
 - Broker/network role; niche service model; project model
16. Communications through CSLF: Tom Howard-Vyse, CSLF Communications Taskforce
- Communications experience in climate, energy
 - Worked on communications for Don Valley Project in the UK
 - Aspects of communicating: building expertise, project details, various industry expertise
 - What is the policy climate in 2016? How does government see CCS?



- How do energy and climate goals sit? For example, in the UK, this will involve Treasury, DECC, and others
 - CCS remains a “political orphan”
 - End of commercialization competition and slashing of the £1 billion fund, questions over government commitment, and recent shake-up of DECC
 - Initial observations on CCS and the CSLF:
 - technology is proven; projects exist and can be visited (in some cases)
 - CSLF brand is not widely known; website needs to be revamped
 - Messages may be without a strategic engagement strategy
 - Context: post-COP21, fossil fuel phase-out, public awareness
 - What can be done? Better public outreach/education, government and policy support
 - Overall: strengths and weaknesses remain, as well as opportunities and threats
 - Shared goals: enhance the CSLF, renew public awareness, strengthen political leadership on CCS, broaden coalition
 - Going forward: finding the right place, time, context, audience
 - Communications strategy: advocacy and strategic engagement
 - Aim to create a virtuous cycle
 - Highlight and establish leadership
 - Messaging strategy: public interest must frame CCS messaging
17. Open discussion: Moderated by Kathryn Gagnon, Natural Resources Canada
- How can members and the CSLF pool resources?
 - Is there a repository for projects and other useful information?
 - Shared space, one-stop shop
 - How is success defined in the CCS realm? For example, how would a project’s success be defined?

Session 4: Academic Community and Capacity Building

18. International Capacity Building Activities: Stuart Haszeldine, Scottish CCS (Absent)

19. Capacity Building in Mexico: Jazmin Mota Nieto, Secretariat de Energia (SENER), Mexico

- Within capacity building efforts in Mexico, focus is on encouraging involvement in CCS across various sectors
- Currently preparing for an upcoming pilot project
- CEMCCUS and CONACYT: collaboration on roadmaps, crafting a strategy with several objectives
- Plan: UNAM and UC Berkeley are developing a joint masters program
 - Specialized curriculum, exchanges, and projects



- Letter of understanding was signed between the University of Alberta and PTRC: work will cover CCUS research and capacity building in Mexico
 - Drawing on expertise from PTRC at Aquistore and Weyburn Midale
 - A memorandum was also signed between Scottish CCS and UNAM
 - Continuing to focus on fostering international exchanges
 - Capacity building work will require CSLF support, ongoing partnerships and projects, collaborations
20. CSLF Capacity Building Program: Adam Wong, U.S. DOE and CSLF Secretariat
21. Open Discussion: Moderated by Chris Littlecott, E3G
- Compared to other disciplines, research agendas and issues do not seem to change in CCS
 - Academics have a large role to play in keeping the ball rolling even if other developments have stalled (ex: regulatory, policy)
 - Academics need to show that technology works and show developments on cost reductions to make it competitive
 - Need to show benefits, spillover effects
 - Sharing labs, infrastructure, and facilities could help as part of collaborative activities
 - Research could be made more efficient
 - Expanding definition of capacity building is necessary
 - Expand role of academics to get them involved in pilot projects and offer help for pre-feasibility studies, project development
 - Post-Paris: sustain linkage to deep decarbonization, emission reduction—highlight the role CCS has to play in this
22. Open discussion: entire group
- Report out to the Policy Group meeting (June 30th) will be given by Jon Gibbins (UKCCSRC)
 - Are these 4 priorities in agenda the right set to focus on?
 - There is some overlap between training and curriculum—sessions 1 and 2 could be combined
 - What are the prospects for online training? Can the Academic Council help to identify and pinpoint online training?
 - The Council should have an ambassador to help ensure capacity and training for carrying out CCS work, projects
 - Aim to utilize the CSLF website to broadcast information, pool resources
 - How can we “embed” students as part of their training?
 - What are the recommendations and asks to the Policy Group?
 - What is the best way to organize this process?
 - Governments have a lot invested already



- How can we utilize existing facilities, capabilities?
- 2 sets of recommendations:
 - Small asks that governments can do
 - Larger asks, long term projects
- Important to keep communications group clued in
 - Important to showcase talent, technologies
- Also important to start work on agreements now—implementing is time-consuming and process can be long
- Will be helpful to put out a call to academics and institutions for their help
- Also aim to make material available (ex: open source, modularized material)
- Many training resources already exist—existing entities and resources should be linked
- There is also the industry connection aspect—how can we create linkages? Look to industry and those who have experience in this field
 - An example is the BHP Billiton/SaskPower Knowledge Centre
- Need to leverage existing summer schools—perhaps focus on creating ones in other countries
- Overall: stick to a flexible and nimble model with fewer restrictions
 - Can be tailored to various areas
- Next steps: what is the best way to move forward?
- Will additional meetings of the Council follow? Ex: CSLF Annual Meeting
- In period before October, will there be additional meetings, webinars?
- How will the group approach the 2017 CSLF Ministerial?



Appendix 3

Current Funding Opportunities

International programs: International programs exist for researchers and academics, including Horizon 2020 in Europe, which generally requires partners from at least three European partner countries. Specific country collaboration calls, such as those with Mexico and South Korea also exist.

Country-specific international funding opportunities:

- **United States:** In the United States, universities often participate in broader international funding schemes. Through the U.S. DOE, funding opportunities are made through the Office of Science, through funding opportunity announcements and national laboratory announcements. Fellowships and internship opportunities are available, with eligibility requirements.
- **United Kingdom:** In the United Kingdom, the ERA-NET scheme offers funding in the amount of €42M, with participants including the UK, Norway, the Netherlands, Spain, Sweden, Turkey, and Greece. Newton funding is also available with various developing country partners (those who meet are ODA recipients). Global Challenges funding is filtered through UK universities.
- **Mexico:** Various funding schemes exist in Mexico, such as periodic scholarships through CONACYT and the Chevening program. CONACYT also matches UK-Mexico Newton funding, with current calls for researcher and institutional links. A new CCS center is in development and will open in 2017.
- **South Africa:** The Newton Fund is also available in South Africa, with periodical funding. The UK Department for International Development (DFID) provides international climate funding opportunities at a regional level.
- **Norway:** Horizon 2020 funding is also available in Norway, along with Marie Curie fellowships within Europe. Academic exchange funding is available through bilateral agreements, with CCS-specific funding through Climit. The Bergen Institute has links with development countries, including study abroad programs, and summer industrial placements. EU and Norway Erasmus programs also exist.
- **Korea:** Korea participates in Horizon 2020, with a matching fund (with links to CCS). An outbound fund sponsors Korean researchers overseas, while a guest lecture program funds international lecturers to Korea for 3-day visits, with additional funding available for workshops. KETP provides \$1.5M for 3 years research as well as internship funding (links between Edinburgh and Yonsei established through this



program). Horizon 2020 also seeks to develop specific links with Korea, with match funding from Korea. There will also be calls coming up for 2017.

- **Canada:** Numerous funding opportunities are available in Canada, such as NSERC funding and fellowships and CCEMC (technology not research focused – ‘shovel ready’ carbon reduction, open to international applications provided technology can be used in Alberta). The University of Regina, sponsored by SaskPower \$3.5M for roughly 5 years, can support internships, coursework (credit or non-credit), thesis data collection, or visits. The BHP-SaskPower Knowledge Centre provides \$20M for research and innovation. COSIA offers the X-Prize, plus regular funding, for technology based projects. MITACS funds student exchanges with industrial focus (inwards and outwards).
- **China:** In China, the China National Science Research Council makes funding available for international collaboration on CCS projects. The Chinese Government also funds opportunities for students to study abroad (EU; AUS; USA), while Chinese Newton funding possibilities also exist.



Appendix 4

Canadian Experience of Study Tours

1. CCS Program for visiting Norwegian Delegation to the provinces of British Columbia and Alberta - November 2-6, 2015

This illustrative program has been adapted based on an itinerary that was tailored for representatives of government and research-focused organizations in Norway to meet with leading edge companies and organizations, and visit sites of interest.

Objectives:

- Introduce solutions applicable for smaller scale CCS and CO₂ utilization technologies, as well as showcase solutions in large scale CCS through attendance at the opening of the Quest facility;
- Discuss revenue streams for large scale CCS operations and the importance of CO₂ for EOR;
- Understand CCS regulatory frameworks, long term risk management, and CO₂ storage site selection; and
- Create opportunities for collaboration with government, industry and research communities.

Site visits / meetings included:

Province of BC	
Carbon Engineering (Squamish)	Carbon Engineering is developing industrial scale air-capture technologies, with a site visit opportunity at the Squamish Industrial Scale CO ₂ Recycling Plant Facility.
Inventys Thermal Technologies (Burnaby)	Inventys is commercializing low-cost & energy efficient technology that captures post-combustion CO ₂ from industrial flue gas streams, with a site visit opportunity at the company's analytical lab and testing facilities.
Carbon Capture & Conversion Institute (Richmond)	The Carbon Capture & Conversion Institute (CCCI) is a partnership between CMC Research Institutes (CMC), the University of British Columbia, and BC Research Inc., focusing on the development, scale-up and validation of new carbon capture and conversion technologies. CCCI



	will be headquartered in the new Technology Innovation and Commercialization Centre and when completed in 2017, will allow for site visit opportunities at the pilot plant and lab facilities.
Mantra Energy Alternatives	Mantra is a clean technology company that is working to advance carbon utilization and fuel cell technologies.
Province of Alberta	
Climate Change and Emissions Management Corporation (CCMEC)	The Climate Change and Emissions Management (CCEMC) Corporation, created in 2009, is a not-for profit organization that supports projects that help Alberta to reduce greenhouse gas emissions and adapt to climate change.
Government of Alberta	This includes Alberta Energy, Alberta Environment and Sustainable Resource Development, and Alberta Innovates – Energy and Environment Solutions (AI-EES).
CMC’s Containment and Monitoring Institute Field Research Station	CMC is an independent, not-for-profit business with one key mission – accelerating the development of technologies to eliminate industrial greenhouse gas emissions. In addition to CMC’s CCCI in British Columbia, another CMC-related site visit opportunity is the Containment and Monitoring Institute’s Field Research Station which is a globally unique site in southern Alberta for the development and testing of measurement, monitoring and verification technologies that study CO ₂ injected at shallow depths.
Shell Quest CCS Project	The Shell Quest project, which launched in November 2015, has successfully sequestered 1 million tonnes of CO ₂ deep underground.

Results achieved: Overall, the visit led to a better understanding of the potential to develop joint research cooperation in CCS between Canada and Norway.

2. 3rd North American Trilateral CCS Workshop - October 25 - 27, 2016

This illustrative program is based on an itinerary that is being developed for representatives of government, industry, research-focused organizations, and academia in the U.S., Mexico, and Canada, to build and enhance North American trilateral CCS collaboration.

Objectives:

- Foster greater trilateral CCS cooperation in agreed upon areas of priority;



- Strengthen links and partnerships with government and stakeholder counterparts to work together on trilateral CCS collaborative activities;
- Capacity building for Mexican organizations with an interest in advancing CCS.

Site visits: Boundary Dam / CCTF / Aquistore / Apache-Midale site visits

SaskPower's Boundary Dam Integrated CCS Project	The Boundary Dam Integrated Carbon Capture and Storage Project is SaskPower's flagship CCS initiative. In the fall of 2014, the project came online as the <i>World's First Post-Combustion Coal-Fired CCS Project</i> integrated with a power station.
SaskPower's Carbon Capture Test Facility (CCTF)	Located at the SaskPower Shand Power Station near Estevan, Saskatchewan, Canada, the CCTF provides technology developers with an opportunity to test new and emerging carbon capture systems for controlling carbon emissions from coal-fired power plants.
SaskPower-PTRC's Aquistore Project	Aquistore is a commercial-scale research and monitoring project which demonstrates that storing CO ₂ deep underground (in a brine and sandstone water formation), is a safe, workable solution to reduce greenhouse gas emissions.
Apache-Midale CO ₂ -EOR Project	This project is a working CO ₂ -EOR operation with approximately 2000 tonnes of CO ₂ injected daily into the Midale field.

Anticipated results achieved: Enhanced trilateral CCS cooperation in agreed upon areas of priority; strengthened links and partnerships among government, industry, researchers, and academia in North America; and enhanced capacity building support for Mexico to implement CCS.



Appendix 5

Stakeholder Engagement

Stakeholder engagement is widely recognized as a critical piece of the CCS value chain. Stakeholder engagement can be defined as a multi-directional process that brings together interested and impacted parties to discuss and implement activities that will potentially impact or influence the lives of a particular group of stakeholders. Indeed, stakeholder engagement, public awareness, and public support are often cited as major barriers to the development and implementation CCS projects and policy. At present, many CCS demonstration projects are conducted through partnerships between government, industry, non-governmental organizations, and academia. Demonstration projects and commercial projects coming online have several stakeholder groups, including general public, educators, government, regulators, industry, landowners, farmers, and others depending on specific circumstances. Each stakeholder may have varying interests, information needs, or concerns that need to be acknowledged and addressed.

The stakeholder engagement efforts undertaken by CCS projects, social researchers, and others have strong foundations in work conducted by the IFC-World Bank, IAP2, Revit and in the social sciences related to engagement of stakeholders in socially responsible ways (see Resources Section). Developing a stakeholder engagement strategy that incorporates the needs and cultures of multiple stakeholders provides a roadmap for handling these challenge is a necessity. Many resources are available that define stakeholder engagement best practices, methods, analysis, approach, which can be broken down into different steps such as:

- Stakeholder identification
- Stakeholder classification
- Engagement planning
- Engagement implementation
- Engagement evaluation and refinement

Significant work has been conducted over the past 15 years to developed stakeholder engagement approaches dedicated to CCS projects, regulatory frameworks, and policy. A specific social research network, C2S2RN, for CCS was established in 2006 and later moved to the IEAGHG in 2009. This network conducts annual research collaboration meetings and provides reports on the most up-to-date social research activities. Furthermore, dedicated efforts by the U.S. Department of Energy, World Resources Institute, and Global CCS



Institute provide a comprehensive starting point for CCS stakeholder engagement. Two resources will be described herein and a comprehensive list of resources is provided at the end of this summary.

The U.S. Department of Energy *Best Practices for Public Outreach and Education for Carbon Storage Projects* (US DOE Best Practices, 2009) recommends ten best practices for project developers conducting public outreach and education, ranging from integration of public outreach with project management to tailoring outreach materials to specific audiences. Several projects within the U.S. and around the world have incorporated these project-based best practices and found them to be robust in their applicability to active CCS projects. This set of practical recommendations are focused on project life-cycle and are conducted at the local to regional-scale for areas where projects are located.

The U.S. Department of Energy defined best project-based practices are:

1. Integrate Public Outreach with Project Management
2. Establish a Strong Outreach Team
3. Identify Key Stakeholders
4. Conduct and Apply Social Characterization
5. Develop an Outreach Strategy and Communication Plan
6. Develop Key Messages
7. Develop Outreach Materials Tailored to Audiences
8. Actively Oversee and Manage the Outreach Program throughout the Life of the Project
9. Monitor Performance of the Outreach program and Changes in Public Perceptions
10. Be Flexible – Refine the Outreach Program as Warranted

While the project-based approach described by the U.S. Department of Energy Best Practices are useful and directly applicable by project developers, there can be a need for a broader and more integrated stakeholder engagement process. The World Resources Institute *Guidelines for Community Engagement in Carbon Dioxide Capture, Transport, and Storage Projects* (Guidelines, 2010) call for “creating a culture of effective, two-way community engagement around CCS projects” (p. 10). The Guidelines recognize that interaction between three main groups (community leaders, project developers, and regulators) is necessary for engagement. The Guidelines define five key principles of CCS community engagement:

- 1) Understanding local community context,



- 2) Exchanging project information,
- 3) Identifying level of engagement,
- 4) Discussing project risks and benefits, and
- 5) Continuing engagement through time.

Another critical component of stakeholder engagement is the potential for risk reduction and mitigation through effective processes. The integration of dedicated stakeholder engagement strategies can help reduce project risks and risks associated with public concern. Through the risk assessment process, project management gains insight into potential project risks and can develop risk mitigation strategies and stakeholder engagement for communicating about potential risks. This has proven effective for multiple CCS projects, such as the Illinois Basin – Decatur Project, Quest, Otway, and Boundary Dam.

New research, lessons learned, and best practices for stakeholder engagement continue to emerge from CCS experiences. Updates are expected for the U.S. Department of Energy Best Practices in late 2016. The Global CCS Institute will host a six-part series on stakeholder engagement in 2016-2017 as well as publishing a paper on development of educational programs in developing countries for CCS supported efforts. Effective stakeholder engagement fosters relationships between project developers, regulators, and communities. It is critical to establish open lines of communication and address stakeholder questions and concerns, while identifying and mitigating potential risk.



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