

REVIEW OF CCS TRAINING PROVIDED BY NON-CSLF BODIES

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Background

Capacity to currently undertake large-scale demonstration CCS projects, leading to near-term deployment of CCS technologies, is a critical factor in developed and developing countries alike. A recent review of pilot and demonstration projects in various phases of planning and implementation in North America has shown that there is a shortage of highly-skilled experts, geoscientists and engineers capable of conducting project design, implementation and the associated research. This shortage is more acute in developing countries where there is a lack of knowledge about CCS not only at the technical and scientific level, but also at the decision and policy making level. Recognizing the need to build capacity in emerging economies, the CSLF set up at the Berlin meeting in 2005 a Capacity Building for Emerging Economies Task Force (Capacity Building Task Force in short, or CBTF).

Among the objectives of the CBTF is developing a set of educational resources that all CSLF members can use. Three workshops provided by top CCS experts and with broad participation from developing economies have been conducted under the guidance of CBTF in Pittsburgh, USA, in May 2007, in Porto Alegre, Brazil, in October 2007, and in Dhahran, Saudi Arabia, in January 2008. At the CBTF meeting held in Calgary, Canada, in November 2007, a 2-year plan was presented by the Task Force Chair and discussed by the TF members present at the meeting. The plan, near finalization and likely to be presented at the CSLF meeting in Cape Town, South Africa, in April 2008, envisages holding capacity building workshops over the next two years in China, Colombia, India, Mexico and South Africa. Consequently, development and standardization of workshop presentation and training materials containing the most current CCS information has been identified at the CBTF meeting in Calgary as an area of immediate focus. On the other hand, at the Brazil workshop in October 2007 and at the CBTF meeting in Calgary it was recognized that decision and policy makers in government and the private sector have different needs for education and training than technical staff; consequently the CBTF identified as another near-term priority the development of a CCS training set aimed specifically towards this audience. In discussing the feasibility of preparing core training modules for capacity building, the CBTF recognized at its Calgary meeting that similar training activities took place or are planned by other international bodies, such as the Asia Pacific Economic Cooperation (APEC) and the International Energy Agency Greenhouse Gas Programme (IEA GHG). The author of this report volunteered at the CBTF meeting in Calgary to review the training activities of these bodies and report back to the Task Force, which is the purpose of this document. A full report on the CSLF Capacity Building workshops is provided in the Status Report of the Task Force on Capacity Building in Emerging Economies to be discussed at the Cape Town CSLF meeting in April 2008, and these workshops will not be discussed here.

APEC Workshops

The APEC Expert Group on Clean Fossil Energy initiated in 2003 a three-phase project to explore the potential for CO₂ capture and geological storage and build CCS capacity in the APEC region. The initiative was designed to help non-industrialized member economies successfully identify, evaluate and develop prime CO₂ capture and geological storage projects in their countries; and build capacity for implementation of CCS projects. Financial support was provided by APEC, the Australian, Canadian and U.S. governments, and IEA GHG. In Phase I of the project, a study of the CCS potential in the APEC Asian member economies exclusive of Russia and Japan was conducted. In Phase II, a 15 modules, 2-days training set was developed and a training pilot workshop was held in Seoul, Republic of South Korea, in February 2005. In Phase III, the training material was updated and fine tuned, and two more workshops were offered, in China in October 2006 and in Mexico in May 2007. Phase I was executed by an Australian team, and Phases II and III were produced and delivered by a Canadian team, mainly Alberta based. Some discussions are being held about the need and usefulness of a Phase IV of the project that would offer additional training workshops in east and southeast Asian economies.

The objectives of Phases II and III of the project were:

- Enhance the capacity of APEC developing economies to undertake CCS projects through the use of training materials and workshops
- Build awareness and knowledge & skills capacity around the potential for CO₂ capture and geological storage

The training modules have the following subjects:

1. CCS Overview
2. CO₂ Capture: Post-Combustion
3. CO₂ Capture: Pre-Combustion
4. CO₂ Compression and Transportation
5. Storage Options for CO₂
6. Screening and Selection of CO₂ Storage Sites
7. Health, Safety and Environmental Issues
8. Performance Assessment
9. Legal, Regulatory and Public Opinion Issues
10. Economic Considerations in CCS
11. Clean Development Mechanism

In addition, specific case studies were prepared and presented:

- CCS Potential in Asian APEC Developing Economies
- CCS Potential in Mexico
- SACS (Sleipner) Project: CO₂ storage in deep saline aquifers
- Weyburn CO₂-EOR MMV Project
- Quinshui Basin CO₂-ECBM in China
- Experience of Acid Gas Injection in Canada

Sets of PPT presentations were prepared for each module and case study, as well as associated printed text that, together, form a CCS primer and training manual. The text, with figures, forms a manual – including the case studies – that can be read independently of attending the course. The modules, originally presented in the order in which they are listed above, allow a certain degree of switching and shuffling according to needs, as long as course coherence is maintained.

The two-days workshops were organized in conjunction with other technical meeting (e.g., the South Korea workshop) or as stand alone events (e.g., the Mexico workshop). Through practice and refinement, the workshop format arrived at has the following characteristics:

- interspersed training lectures and case studies that provide variety during the day;
- grouping of CO₂ capture and CO₂ geological storage modules in distinct blocks to allow the audience to participate according to skills and interest;
- provision of open discussions (Q&A) at the end of each day;
- tailoring of subjects, particularly case studies, to the specific conditions and needs of the host country and of the audience.
- interaction with decision and policy makers, whose time and availability are limited, at the beginning and end of the workshop.

Since the preparation of the training material in 2004 and the update of 2006, some of the material contained in the APEC training modules has become out of date because no provisions were made for the continuous maintenance and update of the modules content.

IEA GHG Summer School

The International Energy Agency Greenhouse Gas Programme (IEA GHG) held twice a short, 1-day summary course on CCS, once for Korean engineers in the UK and once in Korea. This CCS overview currently comprises only slides, but the intent is to add notes to each slide such that it will become a self-contained package that IEA GHG members can use. The course was prepared and delivered by IEA GHG staff and had the following outline:

1. GHG mitigation and the need for CCS
2. Overview of CO₂ capture
3. Options for CO₂ transportation
4. Overview of CO₂ geological storage
5. Economics of CCS
6. Legal and regulatory status of CCS
7. Plans for wide scale deployment and barriers to implementation
8. Panel discussion and Q&A

This course is very broad in nature by the very nature of the limited time frame.

Besides this 1-day course, IEA GHG has developed a CCS Summer School that was held for the first time in Germany in 2007, with the intent to be offered annually (2008 in Canada, 2009 in Australia, 2010 in Norway). The course is given to 60 students from

developed and developing countries alike, with a regional focus but international in participation. The course is geared toward young scientists (Ph.D. students and Post Docs) with background in engineering, geo-technologies and socio-economics. The participant students are selected by IEA GHG from applicants to achieve a broad distribution with regard to academic background to ensure broad subject dissemination and penetration. The goal is to provide them with a broad understanding of the issues surrounding CCS and encourage their participation and choice as a career path in CCS.

The summer school, which is a week-long exercise held in an attractive environment (location), comprises presentations only and currently there is no intent to add course notes, the intent being to run it as a teaching course only. In addition to auditing the presentations, the students are broken into teams to undertake short research activities, with a project presentation at the end of the course. The presentations are given by various international experts that are recruited on an ad-hoc basis. The experts are in residence for the full duration of the Summer School and are available for meeting with the students and for discussions in their respective area of expertise, on project topics and on broader related subjects.

The 2007 Summer School curriculum mirrored the structure of the IPCC Special Report on CO₂ Capture and Storage: CO₂ Sources, CO₂ Capture, CO₂ Transportation, Geological Storage, Mineral Carbonation and Utilization, Safety, Costs and Economic Potential, Regulatory Regimes, Implications for Inventories and Accounting.

The program of the 2008 Summer School includes presentations on:

- Day 1 – CO₂ Capture:
 - o Introduction and international aspects
 - o Modern power plant technologies
 - o CO₂ capture technologies,
 - o IGCC, Oxyfuel plant projects and the future of coal-fired power plants
- Day 2 – Geological storage
 - o Overview
 - o Screening projects/criteria
 - o Leakage pathways
 - o Monitoring and risk assessment
- Day 3 – Economics
 - o Transportation
 - o Costs and cost structure
 - o Emission trading
- Day 4 – Socio-political
 - o CCS financing
 - o Legal aspects
 - o Public acceptance
 - o Political issues
- Day 5 – Mixed
 - o EOR and EGR
 - o Safety

Days 1, 2 and 4 end with project work for students, day 3 ends with a social event, and day 5 ends with project presentation by students, discussions and award ceremony.

Concluding Remarks and Recommendations

Clearly the worldwide need for training in CCS training is growing and there are not sufficient capacity (experts) and resources (funding) for providing such training, particularly in developing countries, be they CSLF members or not. Based on the CBTF own experience, that of its individual members, and of the APEC and IEA GHG training activities, it appears that CSLF has an important role to play that, if anything, should be enhanced. CSLF should develop and maintain sets of training materials that can be easily interchanged, providing flexibility in addressing the needs of the audience in the host country. Training should be offered first and foremost to CSLF member countries, but it should be made available to non-member countries as well as long as staffing and funding issues are addressed.

It is suggested to develop two sets of training materials:

- A half-day long set aimed at government and private sector decision and policy makers that should present the need for CCS, the benefits of CCS, the potential for CCS, and the barriers to large-scale implementation.
- A two-days long set aimed at technical professionals and middle management.

The two-days long training set should contain several basic modules and case studies that are interchangeable and, in some cases, could be left out, and several modules that are subject specific. This is the case, for example, of CO₂ enhanced oil recovery, which is particularly relevant in the Middle East but not so in South Africa, or of CO₂ storage in coal beds and ECBMR, which is not relevant in the Middle East, but may offer potential in China, South Africa and India.

Local conditions and interests should be taken into consideration: however not at the expense of the main body of the training workshop as a whole.

In some cases, both in CSLF workshops and other, some subjects were at a too detailed and scientific level, beyond the audience's ability to understand and learn in such a setting, and this was "dictated" more by the individual available to give the lecture than by the training subject itself (i.e., the expert who was available to make the presentation developed it him/herself, not necessarily with a good understanding of the audience and without relating his/her presentation to other presentations in the workshop). The lectures/presentations should be consistent and relatively homogeneous as much as possible. In this respect, it is desirable to develop a permanent set of training presentations, possibly with associated notes if funding is available. These presentations should then be given by various experts in the same subject, depending on availability at the time of workshop.

This review should form the basis for further discussions in CBFT and development of a CSLF Training Program.