



CCOP CO₂ Storage Mapping Program (CCS-M)

S1: CCS-M Launching Seminar, 29 April 2013

**T1: Training Course on Geological Storage Selection and Characterization, 30 April – 3 May 2013
Bali, Indonesia**

Summary Report:

The Launching Seminar (S1) of **CCS-M** was held in Bali, Indonesia on 29 April 2013. This event was conducted by the CCOP Technical Secretariat (TS) in cooperation with the Global CCS Institute (GCCSI), Norway's Ministry of Foreign Affairs through the Royal Norwegian Embassy – Jakarta & PETRAD, and Indonesia's Ministry of Energy and Mineral Resources. Dr. Adichat Surinkum of the CCOP TS and Dr Yunus Kusumahbrata of Geological Agency Indonesia delivered the welcoming addresses. The keynote addresses were delivered by Ms. Tone Skogen of Norway's Ministry of Petroleum and Energy and Dr. Steve Whittaker of the GCCSI and these set the tone of CCS-M activities, S1 & T1.

CCS-M S1 & T1 – 29 April – 4 May 2013, Bali, Indonesia





Ms. Marianne Damhaug of RNE-Jakarta officially launching the CCS-M Program

A total of 42 (Forty two) participants representing the Member Countries of CCOP – Cambodia, China, Indonesia, Japan, Korea, Lao-PDR, Malaysia, Philippines, Thailand, Timor – Leste and Vietnam, and staff from CCOP Technical Secretariat attended the CCS-M events.

The two (2) keynote addresses were delivered by Ms. Tone Skogen of



Ms. Tone Skogen of MOPE, Norway delivering the 1st Keynote Address

Norway's Ministry of Petroleum and Energy and Dr. Steve Whittaker of Global CCS Institute (Australia). Ms. Skogen highlighted Norway's ambitious climate change policy that introduced the CO₂ tax in 1991..*"the ambition has been to combine the role of being a major energy producer with being on the international forefront in safeguarding the environment"*. The Norwegian Government have invested considerable amount of money in various climate initiatives, one of which is the CLIMIT program that started in 2005 with funding of ~EURO125 M for about 200 projects. The other major Norwegian undertaking in CCS is the CO₂ Technology Centre in Mongstad (TCM) – to test, verify and demonstrate different concepts and technologies that can reduce cost and risks to CCS. TCM is a joint venture between the Norwegian state, Statoil, Shell and Sasol.



Dr. Steve Whittaker of GCCSI delivering the 2nd Keynote

Dr. Whittaker presented the GCCSI's role & mission which is anchored on accelerating the development, demonstration, and deployment of CCS globally. Steve also reported that most CO₂ that are currently being stored is with CO₂ for EOR. EOR is a commercial driver and presents opportunities for CCS demonstration, and that regulations and policy are required to transition from CO₂ for enhancing oil/gas recovery (EOR) to CCS.

The keynote address concluded that there are a number of pieces that must be matched to disseminate and deploy CCS at a global scale, and these are:

- Transfer of information, knowledge, and experience;
- The need for a variety of funding mechanisms and incentives; and
- Substantial funding both at home and in relevant developing countries.

1. S1 Technical Presentations

Topic	Presented by
1. CCS Overview: The Global Perspective	Dr. Per Christer Lund (Innovation Norway)
2. CO ₂ Injectivity and Pressure Control	Dr. Harald Johansen (IFE CO ₂ Centre, Norway)
3. CO ₂ Containment and Monitoring	Dr. Harald Johansen
4. CO ₂ Storage Long-term Safety	Dr. Harald Johansen

The CCS Technology presentations from Dr. Per Christer Lund and Dr. Harald Johansen showcased the various CCS technologies that are available and where Norway is deeply involved, covering the whole carbon value chain – from CO₂ source to storage and monitoring. Also presented and discussed were the various challenges and solutions to CCS implementations, and the current status of CCS technologies. The presentations gave recognition to the high level of knowledge contributed by the oil and gas industry in understanding the complexities of the CO₂ reservoir – that is of paramount importance for the long term and safe storage of CO₂. The discussions also arrived at a consensus that Asia will become the most interesting region for CCS, given the huge potential for CCS in coal-power plants and also for CCS-EOR from CO₂-rich gas fields. The CCS-M program implementation will help usher the building of capacities of the CCOP countries, consistent to the Goal and Objectives of the Program.

Mike Carpenter (DNV KEMA CCS Unit) presented the *Qualification of injection sites for CO₂*, making a strong case why guidelines for injection sites are important. Not only do guidelines facilitate knowledge sharing and capacity building but they also promote transparency and therefore, will lead in building acceptance of CCS by the general public. DNV believes that the ability to perform internationally acceptable verification of CO₂ storage will become increasingly significant in the context of global carbon trading.

2. CCOP Member Countries Presentation

The CCOP member country presentations were based on the following:

- Status of CCS and its related activities
 - Legal framework
 - Specific research works
 - Government initiatives
- Potential geological storage of CO₂
- Future plans in CCS (if any)

Country	CCS Status	Geol Storage Potential	Future plans	Remarks
Cambodia	NO CCS activity at present but plans to develop its capacity in CCS for the future. Climate change agenda is focused in energy efficiency.			

<p>China</p>	<ul style="list-style-type: none"> • Early stage in CCS- storage • Research/mapping <ul style="list-style-type: none"> ○ National R & D (863) ○ National basic research (973) ○ Enterprise demonstration projts (17) ○ Intl collaboration (5) • In the process of developing the legal FW for CCS. 	<p>Onshore and offshore basins are considered target for CO₂ storage (potential capacity, BT)</p> <ul style="list-style-type: none"> • Saline aq (1435) • Petroliferous basins (7.8) • Coal beds (12) 	<p>National CCUS plan</p> <ul style="list-style-type: none"> • 2015 – Launch full demo with storage at 0.3M t/a • 2020 – demo at 1M t/a • Developed technical capacity, >1M t/a 	<p>Offered to host a Case study (C3) for CCS-M on CO₂ use (EOR) and storage.</p> <p>Presentation by SINOPEC (PEPRIS)</p>
<p>Indonesia</p>	<p>Committed to reduce GHG- National Action Plan Addressing Climate Change through PD# 61</p> <ul style="list-style-type: none"> • 26% CO₂ reduction by 2020, through <ul style="list-style-type: none"> ○ Energy mix improvement ○ Switch to less carbon fuels ○ Deployment of renewables • To improve energy security with CCS <ul style="list-style-type: none"> ○ EOR ○ Coal to liquid/gas ○ Biomass 	<p>Identified the ten (10) most suitable basins for storage, based on following criteria:</p> <ul style="list-style-type: none"> • Well characterized reservoir • Well-known geol structure • Potential to reuse existing infrastructure. 	<p>Roadmap for CCS Pilot in Indonesia, 2012 – 2018</p> <ul style="list-style-type: none"> • Build knowledge of reservoir performance to support financing and designing of a demo project • 50-100 t/d CO₂ over several months 	<p>Indonesia is a CCS-M case study country (C1) and has been involved in various CCS-related cooperation projects. Recently, ADB funded a Pre-FS Pilot Project in Merbau field (S. Sumatra)</p> <p>Presentation by LEMIGAS</p>
<p>Japan</p>	<p>Framework of CCS research is within these Ministries</p> <ol style="list-style-type: none"> 1. METI (provides budget/subsidy for R&D, demo, CCT/CCS) <ol style="list-style-type: none"> a. Japan CCS Ltd <ol style="list-style-type: none"> i. JAPEX, etc b. RITE c. AIST d. NEDO <ol style="list-style-type: none"> i. AIST, etc 2. MOE (regulation) <ol style="list-style-type: none"> a. JANUS 	<p>Japan has done some studies/evaluation on GHG emission sources and distribution of potential reservoir for CO₂ storage</p> <ul style="list-style-type: none"> • Potential storage capacity – 141 BT 	<ul style="list-style-type: none"> • 2008-2016: demo schedule with pilot (Nagaoka Proj) 20-40 t/d (10,000 T) • 2016-2020: start of industrial initiative 	<p>AIST research works include estimation of potential estimation of storage capacity, modeling and simulation, risk analysis (& tools), etc. These will continue to be shared to CCOP</p>

			(~250K t/y) <ul style="list-style-type: none"> 2020: Commercial (>1M t/y) 	countries. Presentation by GSJ.
Korea	KIGAM (Korea) CCS visions <ul style="list-style-type: none"> Small scale CO₂ storage until 2015 Large-scale demo until 2020 10k t/y demo of mineral carbonation until 2014 Basin characterization is an on-going activity	KIGAM is conducting surveys and studies on onshore basins for CO ₂ storage pilot projects. <ul style="list-style-type: none"> 2013-2014: pilot screening 	<ul style="list-style-type: none"> 2015-2017: site selection, drilling/co nstruction 2018-2020: CO₂ injection & monitoring 	KIGAM is also involved in various international CCS Projects and has been sharing its knowledge to CCOP countries. Presentation by KIGAM
Lao-PDR	NO CCS activity at present but plans to develop its capacity in CCS for the future. Climate change agenda is focused in energy efficiency and adaptation.			
Malaysia				NO presentation. Malaysia is a CCS-M case study country (C2)
PNG				NO participant
Philippines	NO specific program for CCS. The Philippines is presently implementing a Strategy for a low Carbon future, through <ul style="list-style-type: none"> Energy efficiency projects Biofuels act for alternative fuels Natural gas infrastructure development program Green fuels under the renewable program 	Identified storage potential <ul style="list-style-type: none"> Sedimentary basins – O & G Saline aquifers Unconventional storage – geothermal fields, ophiolites, coal beds and shales 	There are limited opportunities for large-scale deployment of CCS before 2024. No existing plans on geological storage study.	The Philippines was involved in the ADB proj “Exploring the potential of CCS in SE Asia”. Presentation by DOE.
Singapore				NO participant
Thailand	Thailand’s Climate Change (CC) Master Plan, 2011-2050. Goal is to reduce CO ₂ emission by about	Estimated Storage potential from petroleum	Potential basins <ul style="list-style-type: none"> Korat 	DMF is the focal point for CO ₂ - EOR –

	<p>100 MT by 2022</p> <ul style="list-style-type: none"> • MONRE <ul style="list-style-type: none"> ○ ONEP (CC master plan) ○ TGO (CDM) • MOE (Alternative Energy Devt Plan 2008-2022) <ul style="list-style-type: none"> ○ EPPO ○ DEDE ○ DMF <p>CCS is not included in the current CC master plan. However, CCS will be used as alternative in GHG mitigation.</p>	<p>reservoir = 1.9 BT</p> <ul style="list-style-type: none"> • >90% in offshore (Gulf of Thailand) 	<ul style="list-style-type: none"> • Pitsanulok • Pattani • North Malay <p>Future studies in geological storage will have to be focused in these basins</p> <p>Continue with capacity building.</p>	<p>looking into CCS in the petroleum sector. EGAT for coal mining and coal-power sector. Thailand was also involved in the ADB proj “Exploring the potential of CCS in SE Asia”.</p> <p>Presentation by DMF.</p>
Timor-Leste	<p>NO CCS activity at present but plans to develop its capacity in CCS for the future. Climate change agenda is focused in energy efficiency.</p>			
Vietnam	<p>Preliminary research about CCS</p> <ul style="list-style-type: none"> • CO2 injection sites for EOR – completed the 1st phase of in house study 	<ul style="list-style-type: none"> • Onshore mature fields • Offshore mature fields for EOR/Storage • Onshore Pre-cenozoic structures 	<ul style="list-style-type: none"> • Capacity building development 	<p>Vietnam was also involved in the ADB proj “Exploring the potential of CCS in SE Asia”.</p> <p>Presentation by PetroVietnam</p>

3. T1: Training Course on Geological Storage Selection and Characterization



Prof. John Kaldi of CO2CRC, leading the T1 training course

Right after (S1) Launching Seminar, a 4-day (T1) training course was conducted in the same venue in Bali. Dr. John Kaldi and Dr. Peter Neal of CO₂CRC (Australia) led the lectures and exercises based on the theme and also covered the broad CCS spectrum and the carbon value chain. Also present during the course were the CCS experts from Norway and GCCSI who delivered the technical presentations during S1.

The course introduced the various criteria for assessing sedimentary basis for CO₂ storage and characterization of potential storage reservoir.

Topic	Presented by
1. Why CCS	Prof. John Kaldi (Chief Geoscientist, CO ₂ CRC)
2. Storage	Prof. John Kaldi
3. Capture and Transportation Fundamentals	Dr. Peter Neal (UNSW and CO ₂ CRC)
4. Economics	Dr. Peter Neal
5. Economic Opportunities (EOR)	Prof. John Kaldi
6. CCS Projects around the World	Prof. John Kaldi and Dr. Steve Whittaker
7. Conclusions	Prof. John Kaldi together with rest of the speakers

3.1 Criteria for assessing sedimentary basins (modified after Bachu, 2003)

1. Tectonic stability
2. Size
3. Depth
4. Reservoir-seal pairs
5. Faulting intensity
6. Geothermal gradient
7. Hydrocarbon potential
8. Coal and Coal rank
9. Salts
10. Onshore/offshore
11. Climate
12. Accessibility
13. Infrastructure

3.2 Basic criteria for site characterization

1. Injectivity (can we put the CO₂ into the rock?)
2. Containment (can we keep the CO₂ in the rock?)
3. Storage Capacity (what volume of CO₂ can the rock hold?)

Future training courses and workshops in CCS-M will again re-visit these criteria for further discussions and to agree on the specific criteria to use for the CCOP geological storage selection guidelines. The course also emphasized (& reiterated) the important role of the government in identifying and providing the location of storage reservoir and that the characterization of the storage reservoir will take ~7-10 years.



Dr. Peter Neal of UNSW & CO₂CRC, lectures on CCS transport and economics

4. Conclusions and Summaries

1. The global response to climate change will include a range of mitigation measures, including greater energy efficiency, more renewables, lower carbon fuels and CCS – there is no single answer.
2. We will continue to use fossil fuels, so we need to do it in cleaner and smarter ways, and CCS is the best option we have at present for doing this.
3. Commercial deployment of CCS will foster an industry equal in size or larger than the present oil and gas industry.
4. CCS demonstration projects provide confidence that CCS is technically feasible, and will accelerate commercial deployment.
5. CCS will require skills in engineering, geoscience, economics, legal and regulatory areas and will offer broad career opportunities for those prepared for this new technology.
6. The governments will be responsible for providing location of storage sites and there is urgency for these sites to be qualified as storage characterization will take a longer time to be completed (~ 7-10 years).



A Certificate of Participation were given to participants who have completed the 4-day course (T1). Everyone also received a 4 GB thumb drive containing copies of the presentations, list of participants, program and some photos taken during S1 & T1.

The welcome dinner on 29 April was sponsored by the Ministry of Energy and Mineral Resources through the Geological Agency Indonesia while the Farewell dinner by the CCOP Technical Secretariat.

All materials from CCS-M S1 and T1 can also be downloaded for free from the CCS-M website www.ccop.or.th/ccsm.