



- 1. Update on CSLF Collaboration with IEAGHG**
- 2. Update on IEAGHG Activities**
- 3. Learnings from Large-Scale Operational Projects**

Tim Dixon

IEA GHG R&D Programme

CSLF PIRT Meeting 1-3 Feb 2010



Update on CSLF Collaboration with IEAGHG

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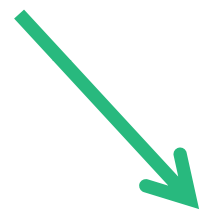
Arrangement between CSLF Technical Group and IEA GHG

- How CSLF TG/PIRT and IEA GHG will interact for mutual benefit through increased co-operation
 - Mutual representation of each at CSLF TG and IEA GHG ExCo (no voting)
 - Liaison with PIRT co-chairs to discuss potential activities or projects – two way process
 - Activities would require approval by ExCo or TG
 - Due reference to org providing the resource
- Endorsed at ExCo Oct07 and TG Jan08



IEA GHG – Project generation

ExCo members



IEA GHG

*Proposal
Outlines*



**ExCo
Member
Voting**

Proposals



ExCo



Studies

CSLF TG



Study Idea Invited



- New study idea invited from CSLF TG/PIRT
- Outline required by end May 2010



Storage Capacity Coefficients



- Report published and now available to CSLF TG/PIRT members
- **‘Development of Storage Coefficients for CO₂ Storage in Deep Saline Formations’**. IEAGHG Report 2009/13
- Offer of presentation at CSLF TG ?







Update on IEAGHG activities

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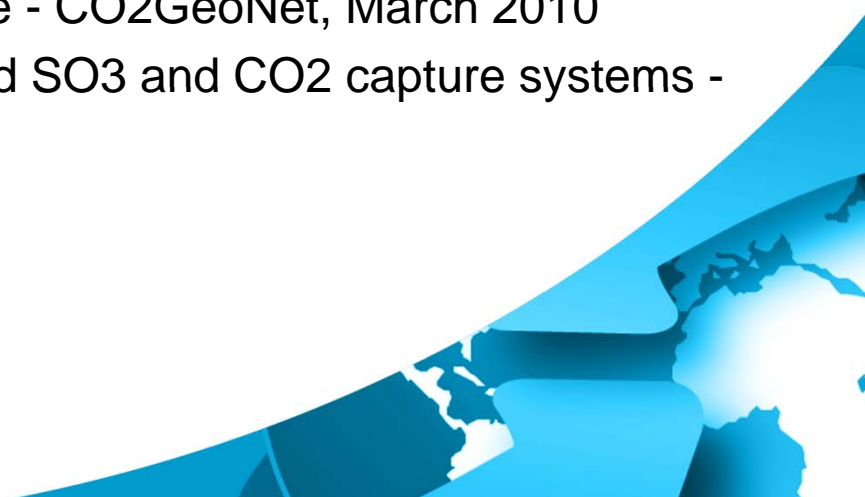
CSLF PIRT Meeting 1-3 Feb 2010



Current Studies (1)

Underway

- Best practice guidelines on site characterisation – DNV, October 2009
- Corrosion and selection of materials for CCS – Innetech, November 2009
- Building the pipeline infrastructure - Element Energy, December 2009
- Retrofit and repowering with CCS - IC Consulting, December 2009
- Evaluation of the water usage and loss of power plants with CO2 Capture - Foster Wheeler Italia, January 2010
- Injection Strategies for CO2 Storage Sites - CO2CRC, January 2010
- Quantification techniques for CO2 leakage - CO2GeoNet, March 2010
- Impacts of high concentrations of SO2 and SO3 and CO2 capture systems - Doosan Babcock, March 2011





Current Studies (2)

Pending

- Incorporating future technological improvements in existing CO₂ capture plants
- CO₂ Capture in the Iron and Steel Industry
- Potential Effects of CO₂ Waste Stream Impurities on Geological Storage
- Integration of post combustion CCS in existing industrial sites
- Pressurisation and Brine Displacement Issues for Deep Saline Formation Storage
- Potential Risks to Potable Groundwater from CO₂ Storage
- Barriers to Implementation of CCS - Capacity Constraints
- Potential for Biomass with CCS





Current Studies (3)

New

- Technologies for Deep Removal of Amines and Other Degradation Products from Flue Gas Emissions of the Power Plant with Post-Combustion Capture
- Global Storage Resource Gap Analysis for Policymakers
- Potential financial mechanisms for long term CO₂ liability
- Caprock systems for CO₂ storage
- Feasibility of monitoring techniques for substances mobilised by CO₂
- Impacts of CCS on Emissions of Other Substances





IEA GHG Research Networks

- Bring together international key groups of experts to share knowledge and experience
- Identify and address knowledge gaps
- Act as informed bodies, eg for regulators
- Benefit experts and wider stakeholders
- Depend on experts' time and inputs – valuable and widely appreciated

- CO2 geological storage networks:
 - Risk Assessment ; Monitoring; Wellbore Integrity; Modelling
- Also networks on Post-Combustion Capture; Oxyfiring; High Temp Solid Looping Cycles; Biofixation; Social Research

Risk Assessment Network



- **2009 Risk Assessment, hosted by CO2CRC in Melbourne, 16th – 18th April**
- Highlights:
 - Australian perspective on groundwater impacts
 - Risk communication experiences from Otway and Ketzin
 - Insurance industry perspective
 - Role of Network –stay technically focussed, recognise future constraints on information sharing from commercial projects
 - CO2CRC Otway visit
- Next meeting: 17-18 May 2010, hosted by IPAC at Colorado School Mines, Golden, Denver USA

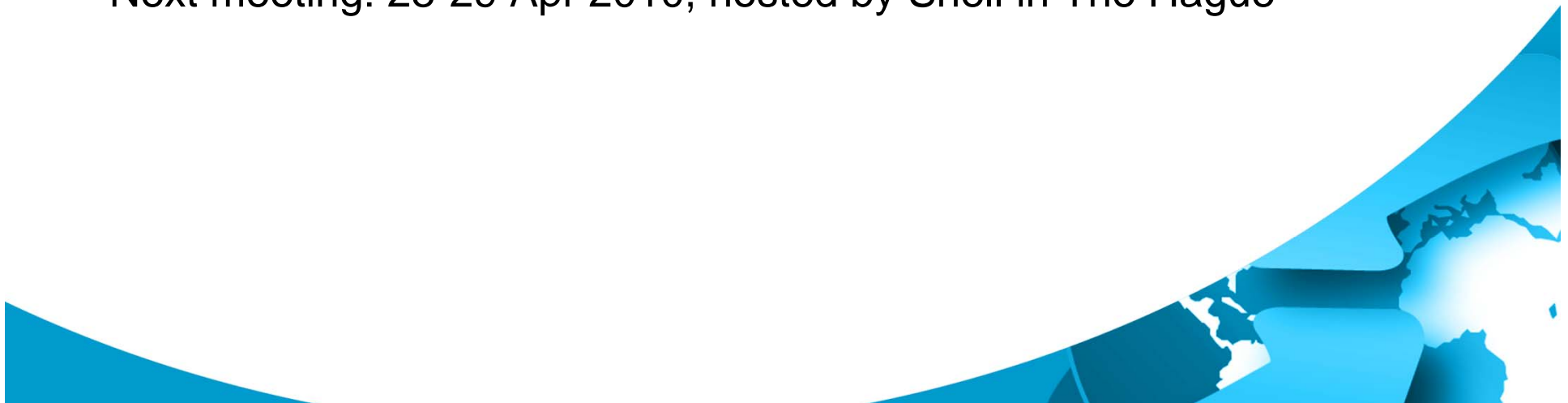




Wellbore Integrity Network



- **2009 Wellbore Integrity, hosted by ARC/TL Watson Associates in Calgary, 13th – 14th May**
- Technical highlights:
 - Focus on industrial/practical experiences including from CO₂-EOR industry
 - Use of alternative plugging materials including ceramics-based cements
 - Lively discussions – industry vs researchers
- Next meeting: 28-29 Apr 2010, hosted by Shell in The Hague





Monitoring Network

- **2009 Monitoring, hosted by RITE, JAPEX, AIST and Kyoto University in Tokyo, 2nd to 4th June.**

Highlights:

- Impressive simulation of liability transfer decision based on seismic imaging and modelling comparisons for Sleipner
- Nagaoka resistivity showing the dissolution of CO₂ in brine
- Recommendation for post-injection monitoring on pilot-projects
- Electrical conductivity survey from Ketzin project and INSAR ground deformation monitoring from In Salah
- Nagaoka project site visit
- Next meeting: 6-7 May 2010, hosted by Texas Bureau of Economic Geology, at New Orleans (tbc), USA



Modelling Network

- 2009 Modelling, hosted by BRGM, near Paris, Feb 2009.
- Next meeting: 16-17 Feb 2010, hosted by University of Utah, Salt Lake City, USA





Social Research Network

- **2009 Social Research Network, hosted by CIRED, Paris, 2-3 Nov (in conjunction with GCCSI event on Public Communications on 4 Nov)**

Conclusions:

- Need to bridge basic and applied research
- Challenge of getting social science research used by decision-makers
- Can't start too early in public engagement

Recommendations

- Within network peer review and pre-review
- Deepen international comparative research
- Greater evaluation of alternative methodologies
- Learning to apply other social science experience to CCS
- Clearing house
- Bridge basic and applied research
- Share best practices



Greenhouse Gas Technologies Conference (GHGT)

- Premier International GHG conference
- Main focus is on CCS
- Held every two years
- GHGT-8, 2006 – Trondheim, Norway
 - 950 Delegates
- GHGT-9, 2008 – Washington, USA
 - 16th – 19th November
 - ~1500 Delegates
- GHGT -10, 2010 – Amsterdam, Netherlands
- www.ieagreen.org.uk/ghgt.html



IEA GHG Collaborations



- GCCSI – Support to demo projects – sharing learning
- EU ZEP, and EU CCS Demonstration Network – sharing learning
- IEA, and IEA Regulators Network (14 Jan webinar on Copenhagen, 20-21 Jan full meeting)
- CSLF
 - Collaboration Arrangement with CSLF Technical Group / PIRT
 - Collaborate/contribute in Risk, Capacity, Academic Task Forces,
 - IEA GHG Student Forum planned with CSLF, web-based
- IEA/CSLF/GCCSI-G8
- APP Programme – Oxy Fuel working group
 - Shadowing our Oxy Fuel network meeting
- IPAC



A world map is centered in the image, surrounded by numerous logos and national flags of energy companies. The logos include: VATTENFALL, ALSTOM, B&W power generation group, BG GROUP, bp, Statoil, TOTAL, Swiss flag, UK flag, USA flag, Australia flag, Austria flag, Canada flag, DENMARK flag, CEZ GROUP, Shell, Sweden flag, EU flag, Chevron, Schlumberger, Spain flag, Finland flag, RWE (The energy to lead), South Africa flag, CIAB, REPJOL YPF, Norway flag, France flag, ConocoPhillips, JGC, Australia flag, Hungary flag, South Korea flag, Japan flag, India flag, Germany flag, eni, GLOBAL CCS INSTITUTE, ExxonMobil, and EPRI. The e-on logo is also present at the bottom right of the map area.



What Have We Learnt from Large Scale Operational Projects

*Tim Dixon, Neil Wildgust, Mike Haines,
Brendan Beck*

IEA GHG R&D Programme

CSLF PIRT Meeting 1-3 Feb 2010



What have we learnt to date from Large Scale Operational Projects?

- Review current operational large-scale CCS projects
 - Assess learning from projects
 - Identify gaps in the global CCS project portfolio
- Focus on projects relevant to full-commercial scale operation
 - Includes:
 - Large-scale pilot
 - Demonstration
 - Commercial
 - Excludes
 - Small and medium pilot
 - Lab scale
- Define criteria – Identify projects – Collect information - Analyse








Criteria for large-scale operational projects

- Indicative criteria defined for 'large-scale operational projects'
- Was, or had been, operational by the end of 2008, and either:-
 - Captures over 10,000 tCO₂ per year from a flue gas
 - Injects over 10,000 tCO₂ per year with the purpose of geological storage with monitoring
 - Captures over 100,000 tCO₂ per year from any source
 - Coal-bed storage of over 10,000 tCO₂ per year
- Commercial CO₂ EOR is excluded unless there is a monitoring programme to provide learning.
- Does not need to be fully integrated
- Added term 'large-scale operational' to IEA GHG Projects database



Projects identified

Bellingham Cogeneration Facility	IFFCO CO2 Recovery Plant – Aonla	Capture over 100ktCO ₂
CASTOR Project	Prosint Methanol Plant	Capture over 100ktCO ₂
Great Plains Synfuel Plant	Rangely CO2 Project	Monitored EOR over 10ktCO ₂
IMC Global Soda Plant	Schwarze Pumpe	Capture over 100ktCO ₂
In Salah	SECARB - Cranfield II	Injection over 10ktCO ₂ for storage
K12-B	Shady Point Power Plant	Capture over 100ktCO ₂
Ketzin Project	Sleipner	Injection over 10ktCO ₂ for storage
MRCSP - Michigan Basin	Snohvit LNG Project	Injection over 10ktCO ₂ for storage
Nagaoka	SRCSP - Aneth EOR-Paradox Basin	Monitored EOR over 10ktCO ₂
Otway Basin Project	SRCSP - San Juan Basin	Coal bed storage over 10ktCO ₂
Pembina Cardium Project	Sumitomo Chemicals Plant	Capture over 10ktCO ₂ from flue gas
Petronas Fertilizer Plant	Warrior Run Power Plant	Capture over 100ktCO ₂
IFFCO CO2 Recovery Plant - Phulpur	Weyburn	Monitored EOR over 10ktCO ₂
Chemical Co. "A" CO2 Recovery Plant	Zama EOR Project	Monitored EOR over 10ktCO ₂

-  Capture over 100ktCO₂
-  Injection over 10ktCO₂ for storage
-  Monitored EOR over 10ktCO₂
-  Capture over 10ktCO₂ from flue gas
-  Coal bed storage over 10ktCO₂

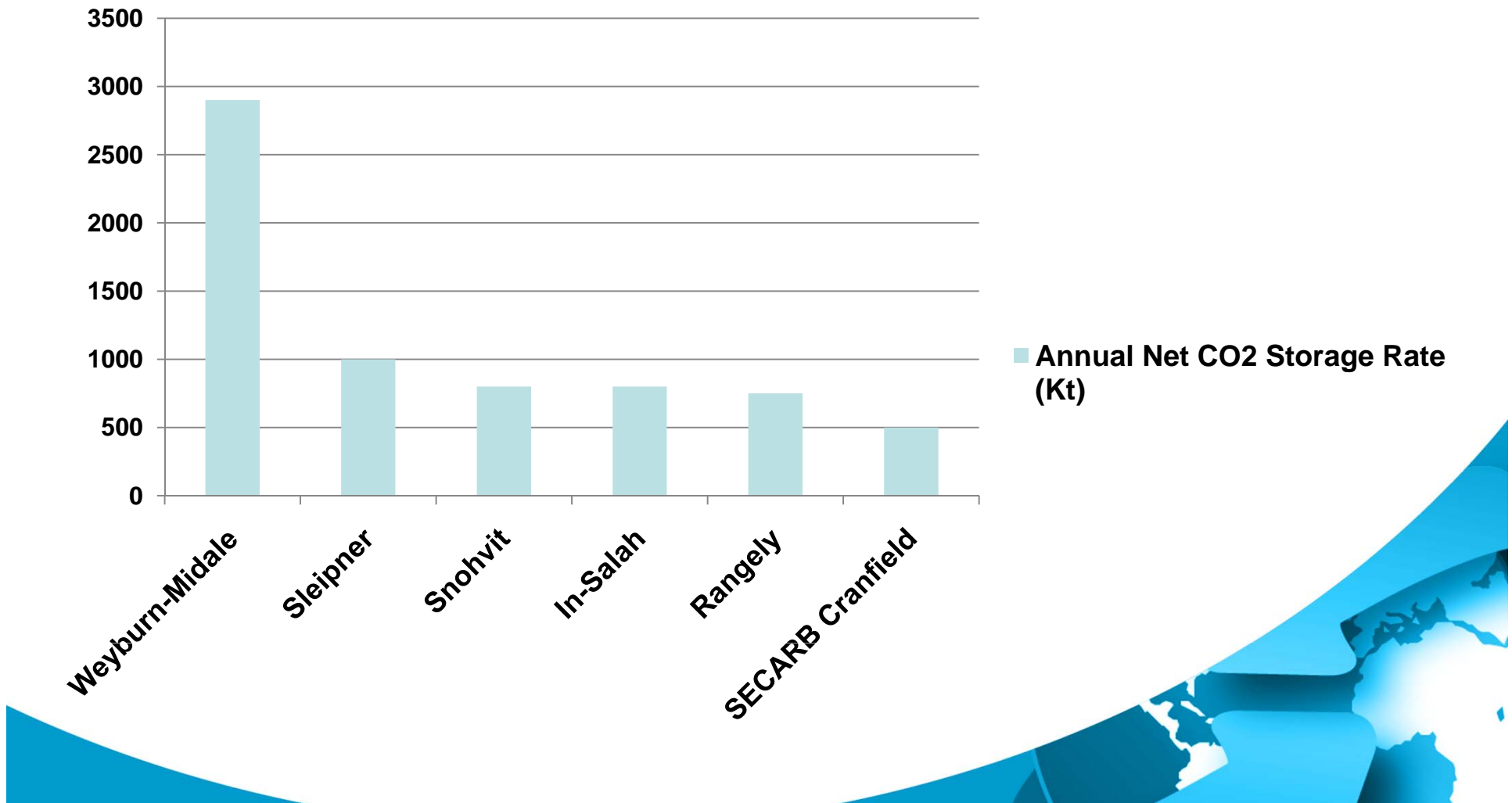
Extent of coverage – Storage amounts



- There are six projects that store over 40,000t CO₂ per year
- All projects combine store almost 6Mt per year
- Total of 57 project years of CO₂ storage experience
- Over 40Mt of CO₂ stored



Net CO₂ Storage per Year



Common Monitoring Techniques



Technique	No of Sites	Positive comments	Negative comments
DH temp/pressure	11		
Surface seismic	10	2	3
Soil gas	9		
Geochemical	8	1	
VSP	8		1
Microseismic	7		1
Gravity	4		1
Crosswell seismic	3	1	1
Electrical Conductivity	3	1	
Satellite	3	1	



Extent of coverage vs ZEP project matrix

Archetype 1	• Lignite/co-firing with Biomass	• Pre-combustion, variant A	• Cross-border pipeline	• Offshore depleted oil & gas field
Archetype 2	• Gas	• Post-combustion, variant A	• Pipeline	• Onshore structural deep saline aquifer
Archetype 3	• Hard Coal	• Oxy-fuel, variant A	• Ship	• Offshore open deep saline aquifer
Archetype 4	• Hard Coal	• Post-combustion, variant A	• Pipeline	• Onshore depleted oil & gas field
Archetype 5	• Lignite	• Oxy-fuel, variant B	• Pipeline	• Onshore structural deep saline aquifer
Archetype 6	• Hard Coal	• Pre-combustion, variant B	• Pipeline	• Offshore depleted oil & gas field
Archetype 7	• Hard Coal	• Post-combustion, variant B	• Pipeline	• Onshore open deep saline aquifer

Demonstrated in operational large projects

Not demonstrated in operational large projects

Project matrix courtesy of EU Technology Platform for Zero Emission Fossil Fuel Power Plants - ZEP (2008)

Themes in Key Learning Points



- Effectiveness of monitoring techniques – what to drop and what to develop
- Injectivity – prediction, restoration and enhancement
- Dealing with hydrates
- Performance of materials in CO₂ environments
- Well designing, placing, monitoring



