Update on IEAGHG activities

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IEA GHG R&D Programme

CSLF TG Meeting 21 September 2011

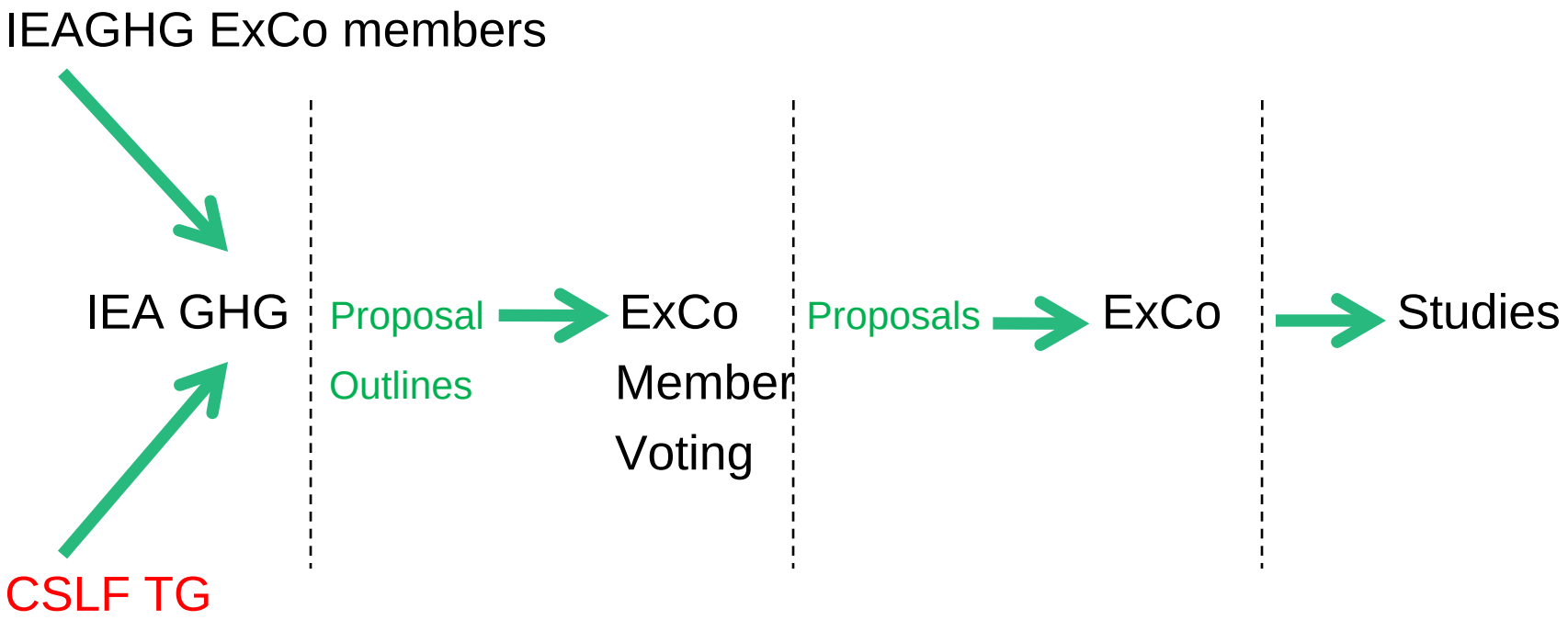
IEA Greenhouse Gas R&D Programme

- A collaborative research programme founded in 1991 as an IEA Implementing Agreement financed by its members
- Aim: Provide members with definitive information on the role that technology can play in reducing greenhouse gas emissions.
- Producing information that is:
  - Objective, trustworthy, independent
  - Policy relevant but NOT policy prescriptive
  - Reviewed by external Expert Reviewers
  - Subject to review of policy implications by Members
- Activities: Studies and reports (>120); International Research Networks : Wells, Risk, Monitoring, Modelling, Oxy, Capture, Social Research; Communications (GHGT conferences, IJGGC, etc); facilitating and focussing R&D and demonstration activities eg Weyburn; peer reviews; Summer School series.

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



First study idea from CSLF: 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
- Presentation at CSLF TG Mar 2010

New Study Ideas Invited

- Two ideas provided by CSLF in 2010 :- Storage in Basalt; Storage and Shales
- Proposals submitted for member voting for Sep 2010 ExCo. Resubmitted to voting for Apr 2011 ExCo. Storage and Shales received enough votes, Basalt did not.
- Storage and Shales approved by ExCo (soon out for tender, interested contractors)
- Storage in Basalt was done instead as internal technical review, initial results presented at April ExCo. Due to be published soon.

- **Additional new study ideas invited from CSLF TG/PIRT**

- **Outlines required by Dec 2011**

Geological Storage of CO_2 in Basalts

- Technical review by Millie Basava-Reddi

- Storage Mechanisms
- Potential Storage Locations
- Real Projects
  - Wallula pilot project
  - Carbfix pilot project
- Conclusions and Recommendations

Basalts - Storage Mechanisms

- Structural
  - Thick sequences of cyclical volcanic events
  - Brecciated flowtops – high permeability layers
- Mineral Trapping
  - Permanent
  - Significant quantities of Fe, Mg, Ca, react with CO_2 to form carbonates

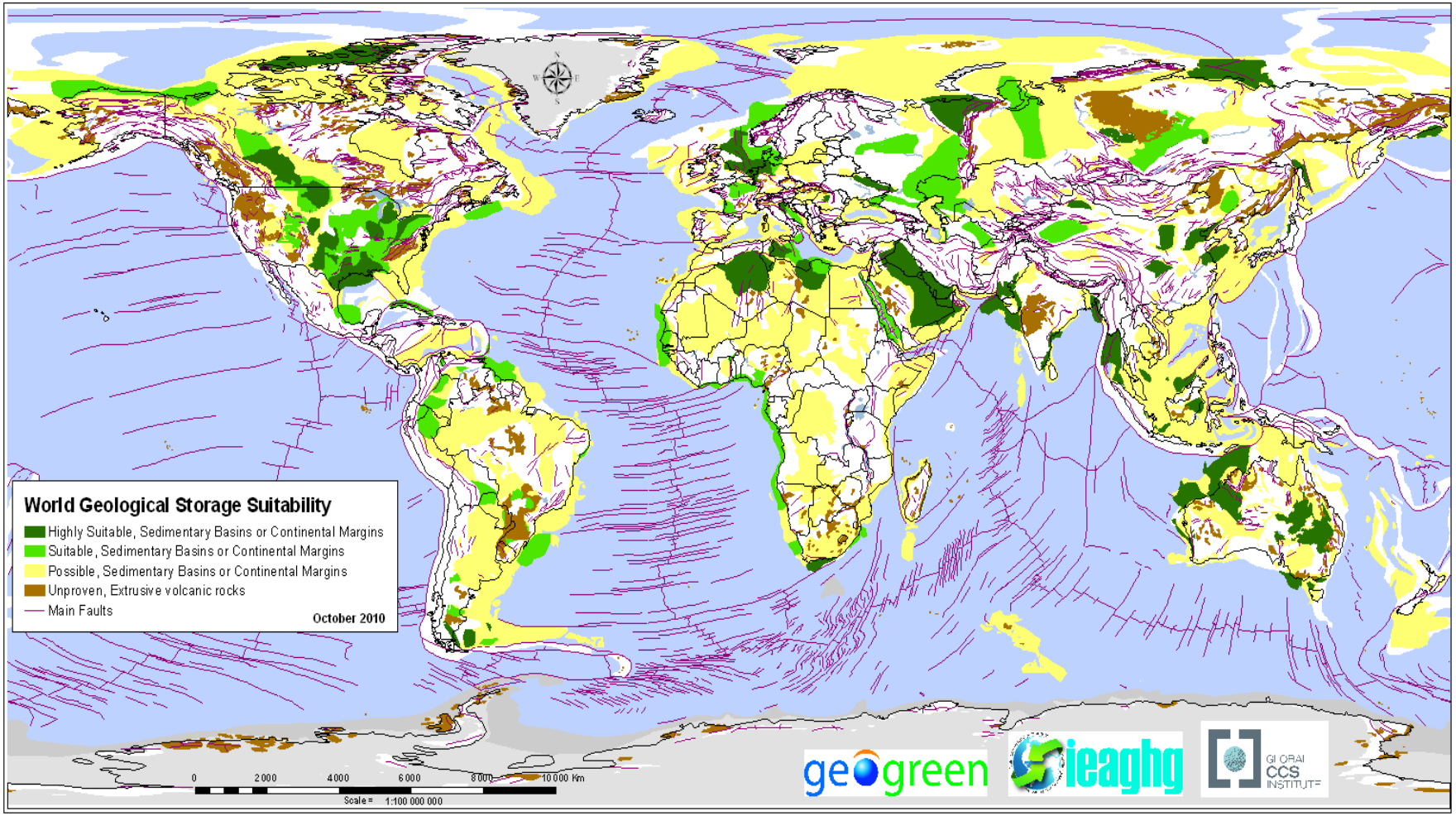
Basalts - Lab experiments

- Illustrate effects of depth, by varying pressure and temperature
- Increased depth → more carbonate precipitates
- basalts less stable with increasing depth
- shallower depths calcite is formed - Ca^{2+} is dominant; depth increases concentration of other cations (Fe^{2+}, Mg^{2+}, Mn^{2+}) increases
- indication of certain basalt components, such as pyroxenes becoming less stable

Basalts - Lab experiments – cont.

- Reactions with water rich supercritical CO_2 ($scCO_2$) are not as well understood as those with the aqueous solution,
- Experiments show distinctly different products.
- The wet CO_2 experiments form smaller, but more abundant minerals, sometimes completely coating the basalt surface.
- Further research is being carried out

Basalts - Potential Storage Locations



Basalts - Real Projects - Carbfix

- CO_2 captured from Hellisheidi geothermal plant
- Planned injection of dissolved CO_2 at 400 – 800m
- Initially 2200 t/yr, but will be increased if first test successful (geothermal plant produces 60,000 t/yr)
- 1 t CO_2 : 27 t water
- Dissolved CO_2 – standard geophysical monitoring techniques difficult
- Use of geochemical tracers

Basalts - Real Projects - Wallula basalts

- $scCO_2$ to be injected into interflow zone of 3 separate flows
- Pilot test 1000 t CO_2
- Seismic processing techniques updated for basalts.
- Planned injection spring 2011 (though has been pushed back a few times)
- Lab tests show that expected time for complete mineralisation from pilot – 10 years

Basalts - Conclusions

- Storage in basalts is untested
- Laboratory experiments and modelling show that storage in basalts and in-site mineralisation of CO_2 is feasible
- $scCO_2$ reactions – not yet fully understood, further research is ongoing
- Pilot projects are expected to commence in the near future.

Current Studies (1)

Recently completed and/or published:

- Caprock Systems for CO_2 Geological Storage - CO2CRC, 2011-01, June 2011
- Retrofitting CO_2 Capture to Existing Power Plants - IC Consultants Ltd,- 2011-02, May 2011
- Effects of Impurities on Geological Storage of CO_2 – Canmet ENERGY, 2011-04, June 2011
- Potential for Biomass and Carbon Dioxide Capture and Storage – Ecofys, 2011-06, July 2011
- Rotating Equipment - Foster Wheeler, 2011-07, September 2011
- Storage Cost Calculator - Joint Report with ZEP, August 2011
- Global Storage Resource Gap Analysis for Policymakers (GCCSI) – GeoGreen, 2011-08, October 2011
- Ground Water Impacts - CO2GeoNet, 2011-10, October 2011
- CCS Capacity Constraints – Ecofys, 2011-11, November 2011
- Impacts of high concentrations of SO2 and SO3 and CO2 capture systems - Doosan Babcock, 2011-09, December 2011

Current Studies (2)

Underway

- Incorporating future technological change in existing capture plants – IC, January 2012
- Emissions other than CO_2 from power plants with CCS – TNO, January 2012
- Quantification techniques for CO2 leakage - CO2GeoNet, January 2012
- Feasibility of Monitoring Techniques for Substances Mobilised by CO_2 Storage in Geological Formations - CO2CRC, January 2012
- Evaluation of CO_2 Post-Combustion Capture Chemical Emissions and Technologies for Chemicals Deep Removal – CSIRO, February 2012
- Ethical Attitudes to CCS – UMIST, February 2012
- Iron and Steel study – MEFOS, June 2012
- Removal of impurities from CO_2 – Advantica, June 2012
- Abstraction of brine from geological storage formations - CO2CRC, November 2011
- Financial Mechanisms for Long Term Liability – ICF, December 2011
- Operating Flexibility of CCS in Future Energy Systems – IC, December 2011
- Capture in Gas Fired Power Plant - Parsons Brinkerhoff, December 2011
- Co2RiskMan – DNV, June 2012

Current Studies (3)

Pending

- Post Combustion Capture Process Scale-up Challenges and Strategy
- Induced Seismicity
- Key Messages for Stakeholders
- Subsurface Resource Interactions
- Implications of Gas Production from Shales and Coals
- Potential for Reducing the Life Cycle GHG Emissions of CCS Plants
- Use of Renewable Energy in CO_2 Capture Processes
- Ship Transport of CO_2

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
- **Research Networks:**
  - Risk Assessment
  - Monitoring
  - Wellbore Integrity
  - Modelling (storage)
  - Post-Combustion Capture
  - Oxyfiring
  - High Temp Solid Looping Cycles
  - Social Research

Modelling and Wellbore Integrity Networks

- **Combined meeting: Perth, W Australia. 25-27 April. Hosted by Curtin and UWA**
- Visit to planned Collie Southwest CO_2 Hub
- Modelling is site-specific
- Simplified models allow exploration of a wide range of scenarios on a short time-scale – but may not improve the overall understanding of the reservoir
- Assessment of caprock systems is highly site-specific
- Noticeable lack of data on reservoir stress paths, and there is a need for further 1D and 2D pressure, temperature and flow control experiments when modelling leakage rates.
- Modelling help with public communication issue
- Research into wellbore integrity issues continues to improve understanding of the performance of cements and other well materials in the presence of CO_2, highlights the importance of field data from projects such as Weyburn-Midale to calibrate studies.

Monitoring Network

- **Potsdam, Germany, 1-3rd June 2011, hosted by GFZ**
- Theme: EU criteria for transfer of responsibility :
- *Actual behaviour of the injected CO_2 conforms with modelled*
- Seismic detection limits discussed for real projects.
- Will always be the case that the models improve with more info.
- Combinations of tools can reduce overall uncertainty. Results from pilot sites are key for understanding and demonstrating processes
- *No detectable leakage*
- Traditional techniques includesoil-gas and atmospheric monitoring as well as monitoring of shallow water. Very important to capture the full natural variation of CO_2. A 2 step approach to first locate the leak, then quantify it.
- New process based approach to soil monitoring.
- Results from monitoring at the Ketzin project, visit to Ketzin project.
- Use of risk assessments to define monitoring programmes

Risk Assessment Network Meeting

- **Pau, France, 21-23rd June, hosted by BRGM**
- Including biosphere risk assessment and community asset values
- Induced seismicity
- Understanding potential groundwater impacts: In-situ CO_2-water-rock interactions may not be as important as migrated brine interactions; Buffering and scavenging processes may control trace element mobility
- Microbial activity can have both physical (e.g. porosity) and chemical impacts (e.g. catalysis of mineral reactions)
- Shell, BP, TOTAL updates on projects' risk assessments
- Visited the TOTAL Lacq-Rousse project
- Key recommendations: monitoring programmes should be risk-based; the need for benchmarking of outputs of methodologies; community asset values being included; investigation into microbial influences; consideration of induced seismicity for larger projects, the importance of baseline data; further work is needed on the evolution of risk through time.

CCS Summer School 2011

- Hosted by Illinois State Geological Survey, in Champaign, Illinois, 18th – 22nd July
- 53 students attended from 25 countries.
- As well as the technical programme and group work, the students visited the Illinois Basin – Decatur Project (IBDP)

Other meetings:

- Post Combustion Capture Conf 1 – May, Abu Dhabi
- Oxyfuel Combustion Conf 2 – 12-16th Sep, Queensland
- High Temperature Solid Looping Network, 30th Aug- 1st September, Vienna

Forthcoming:

- Bio-CCS International Workshop, 25-26th Oct 2011, Cardiff, UK (EU ZEP and EBTP)

- GHGT 11 – 18-22nd Nov 2012, Kyoto

IEA GHG Collaborations

- GCCSI
- EU ZEP, EU CCS Demonstration Network, EU Bio-CCS TF
- IEA, and IEA Regulators Network
- CSLF
- APP Programme – Oxy Fuel working group
- IPAC
- CO2GeoNet
- UNFCCC and London Convention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