



- 1. Update on CSLF Collaboration**
- 2. Update on Activities**
- 3. Storage Coefficients Study**

***Neil Wildgust and Tim Dixon***

***CSLF TG Meeting 15-16 Mar 2010***



A world map is centered in the image, surrounded by numerous logos and national flags of energy companies. The logos include:

- VATTENFALL** (with a sun and water icon)
- ALSTOM**
- B&W** (power generation group)
- BP** (with a green sun icon)
- BG GROUP** (with a 'g' icon)
- Statoil** (with a pink flower icon)
- TOTAL** (with a globe icon)
- CEZ GROUP** (with a 'E' icon)
- Schlumberger**
- Shell** (with a yellow and red shell icon)
- Chevron** (with a blue and red chevron icon)
- RWE** (The energy to lead)
- CIAB** (with a globe icon)
- REPSOL YPF** (with a red and yellow sun icon)
- ConocoPhillips** (with a red and white chevron icon)
- JGC** (with a red and white 'JGC' icon)
- ExxonMobil**
- EPRI** (GLOBAL CCS INSTITUTE)
- e-on** (with a red and white 'e-on' icon)
- eni** (with a black and red lion icon)

National flags are also scattered around the map, representing various countries including the United Kingdom, USA, Australia, Austria, Canada, Denmark, Norway, Sweden, Spain, South Africa, Finland, France, Germany, India, Japan, South Korea, and the European Union.



# Update on CSLF Collaboration with IEAGHG



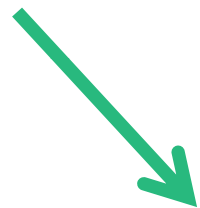
# Arrangement between CSLF Technical Group and IEA GHG

- 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**

**CSLF TG**



*Proposal  
Outlines*



**ExCo  
Member  
Voting**

*Proposals*



**ExCo**



**Studies**





## Study Ideas Invited

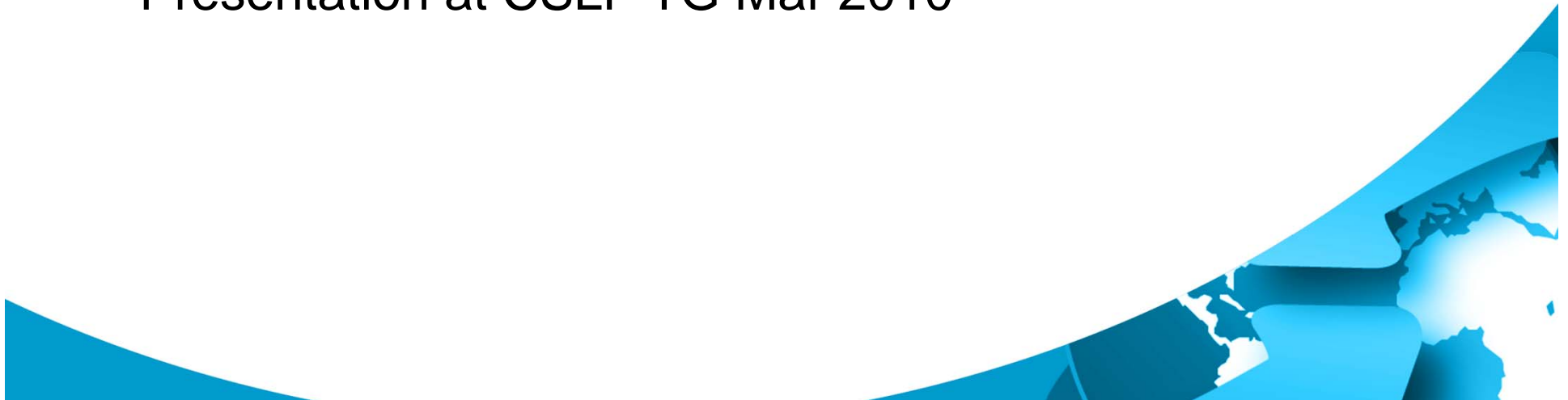
- New study ideas invited from CSLF TG/PIRT
- Outline required by end May 2010



# Storage Capacity Coefficients



- Report published and now available to CSLF TG/PIRT members
- **‘Development of Storage Coefficients for CO<sub>2</sub> Storage in Deep Saline Formations’**. IEAGHG Report 2009/13
- Presentation at CSLF TG Mar 2010





# Update on IEAGHG activities

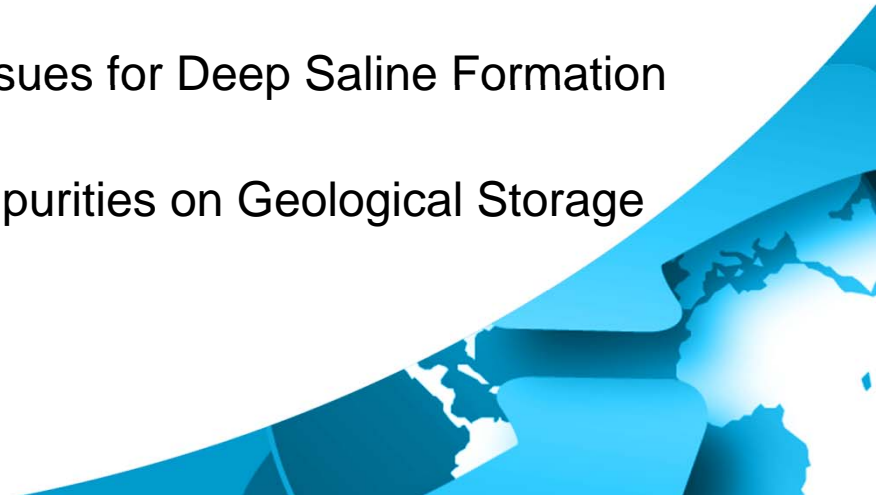


# Current Studies (1)



## *Underway*

- 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 CO<sub>2</sub> Capture - Foster Wheeler Italia, January 2010
- Injection Strategies for CO<sub>2</sub> Storage Sites - CO2CRC, January 2010
- Quantification techniques for CO<sub>2</sub> leakage - CO2GeoNet, March 2010
- Impacts of high concentrations of SO<sub>2</sub> and SO<sub>3</sub> and CO<sub>2</sub> capture systems - Doosan Babcock, March 2011
- Pressurisation and Brine Displacement Issues for Deep Saline Formation Storage
- Potential Effects of CO<sub>2</sub> Waste Stream Impurities on Geological Storage



# Current Studies (2)



## *Pending*

- Incorporating future technological improvements in existing CO<sub>2</sub> capture plants
- CO<sub>2</sub> Capture in the Iron and Steel Industry
- Integration of post combustion CCS in existing industrial sites
- Potential Risks to Potable Groundwater from CO<sub>2</sub> Storage
- Barriers to Implementation of CCS - Capacity Constraints
- Potential for Biomass with CCS
- Global Storage Resource Gap Analysis for Policymakers
- Caprock systems for CO<sub>2</sub> storage



# 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
- Potential financial mechanisms for long term CO<sub>2</sub> liability
- Feasibility of monitoring techniques for substances mobilised by CO<sub>2</sub>
- 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
  
- CO<sub>2</sub> 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, 16<sup>th</sup> – 18<sup>th</sup> 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

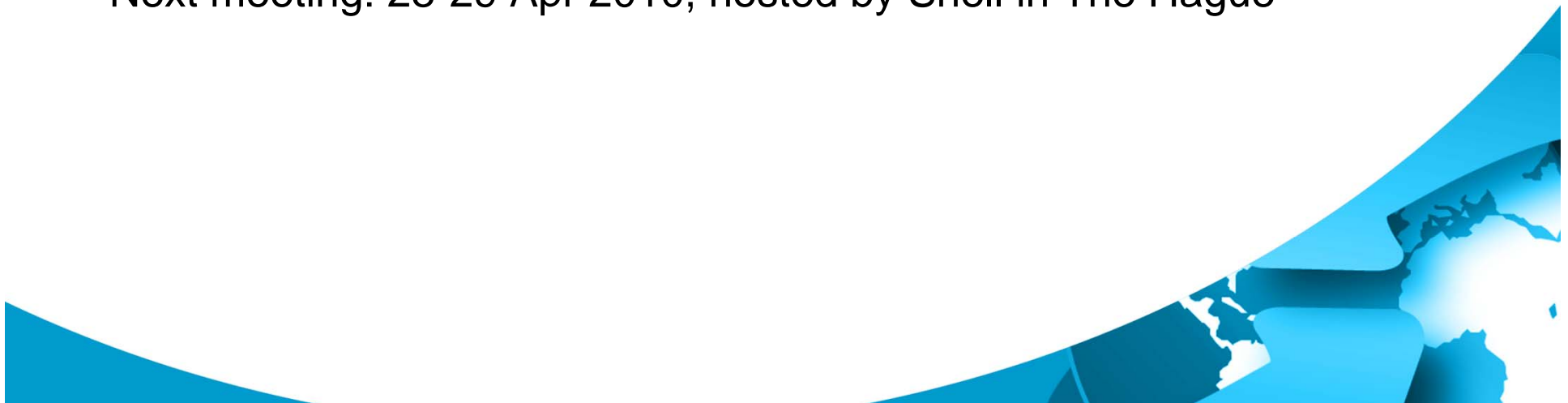




# Wellbore Integrity Network



- **2009 Wellbore Integrity, hosted by ARC/TL Watson Associates in Calgary, 13<sup>th</sup> – 14<sup>th</sup> May**
- Technical highlights:
  - Focus on industrial/practical experiences including from CO<sub>2</sub>-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, 2<sup>nd</sup> to 4<sup>th</sup> June.**

## Highlights:

- Impressive simulation of liability transfer decision based on seismic imaging and modelling comparisons for Sleipner
- Nagaoka resistivity showing the dissolution of CO<sub>2</sub> 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 meeting hosted by BRGM, near Paris, Feb 2009.
- 2010 meeting: 16-17 Feb 2010, hosted by University of Utah, Salt Lake City, USA
- Sessions on recent advances (have there been any?), modelling objectives, updates from real projects, best practice
- Wide ranging discussions on applicability of models, especially for regulatory purposes and in the context of the IEA CCS Roadmap
- Field trip to the Crystal Geyser
- Potential host for 2010 meeting: Shell, Perth, W Australia





# 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
  - 16<sup>th</sup> – 19<sup>th</sup> November
  - ~1500 Delegates
- GHGT -10, 2010 – Amsterdam, Netherlands
- [www.ieagreen.org.uk/ghgt.html](http://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



# Storage Coefficients Study

# Storage Coefficients Study



***CSLF and US DOE storage resource estimation methodologies require development of coefficients***

***Study proposal approved by ExCo33***

***Study undertaken by Energy and Environment Research Centre, University of North Dakota***

***Co-sponsored by US DOE***

***Main aims of the study:***

- Review storage resource estimation methodologies and associated resource classification schemes;
- Compile database of key parameters from injection projects and associated modelling studies;
- Develop a series of storage coefficients that can be applied to regional resource surveys;
- Consider hydrocarbon fields and saline formations

# Storage Classification



## *Methodologies*

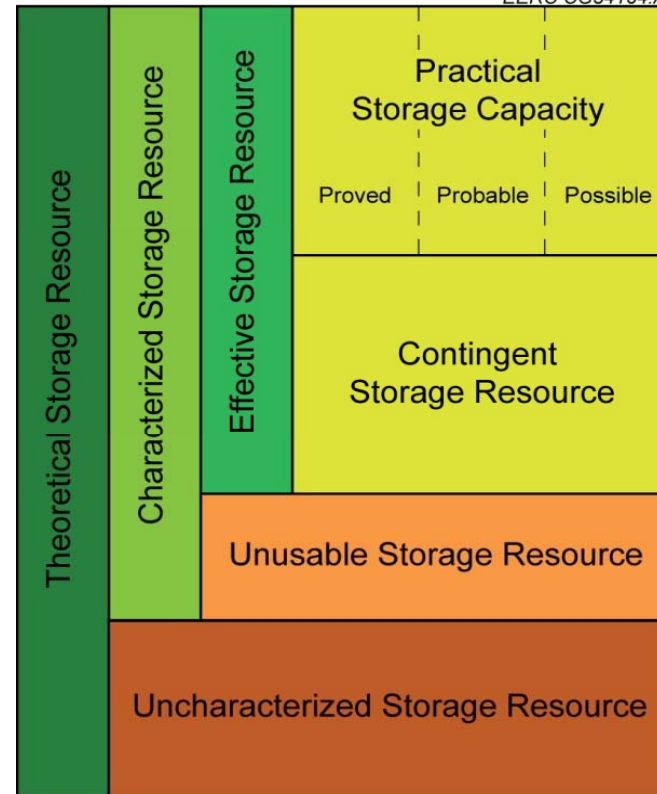
*Focus on US DOE and CSLF methods*

*Two most widely applied methods*

*Methods are very similar from computational viewpoint, with results easily compared*

## *Proposed Classification*

EERC CG34164.AI





# Depleted Hydrocarbon Fields



***US DOE and CSLF methodologies both include volumetric approaches to resource estimation***

***CSLF also includes alternative mass balance approach – storage resource estimation based on recoverable HC reserves, as used by recent IEA GHG studies***

***Decision taken not to develop HC field coefficients for volumetric approach in this study***

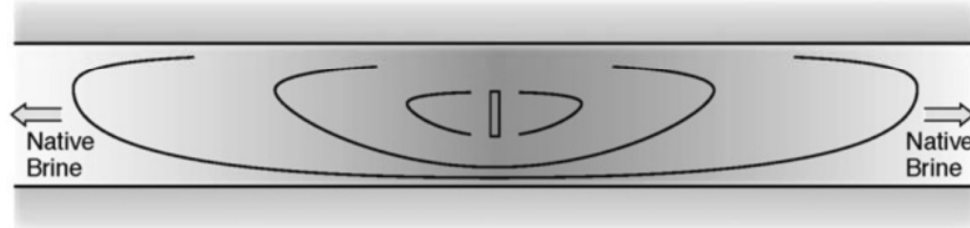


# Deep Saline Formations

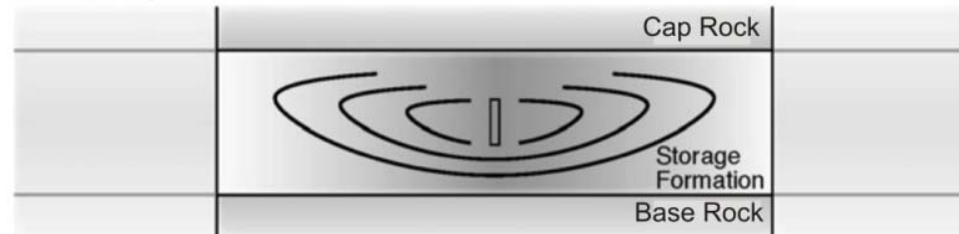


Open System

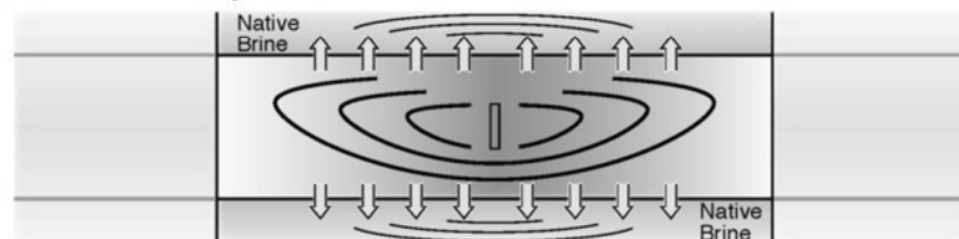
EERC CG34579.CDR



Closed System



Semiclosed System



ESD07-026

# Methodology



***Paucity of 'real-world' projects and data***

***Approach employed: modelling from database of likely DSF characteristics developed from HC field databases and literature search***

***Provided statistical datasets for modelling***

***Uniform injection and evaluation scheme developed for modelling runs***

***Coefficients for Effective Resource derived at site scale, extrapolated to formation scale***



# Modelling Assumptions



***Coefficients derived for time at cessation of injection***

***Trapping dominated by physical containment, but solution and residual trapping also included***

***Plumes defined by the extent of free-phase CO<sub>2</sub>***

***Homogeneous models initially run with averaged properties to assess parameter sensitivity***



# Modelling

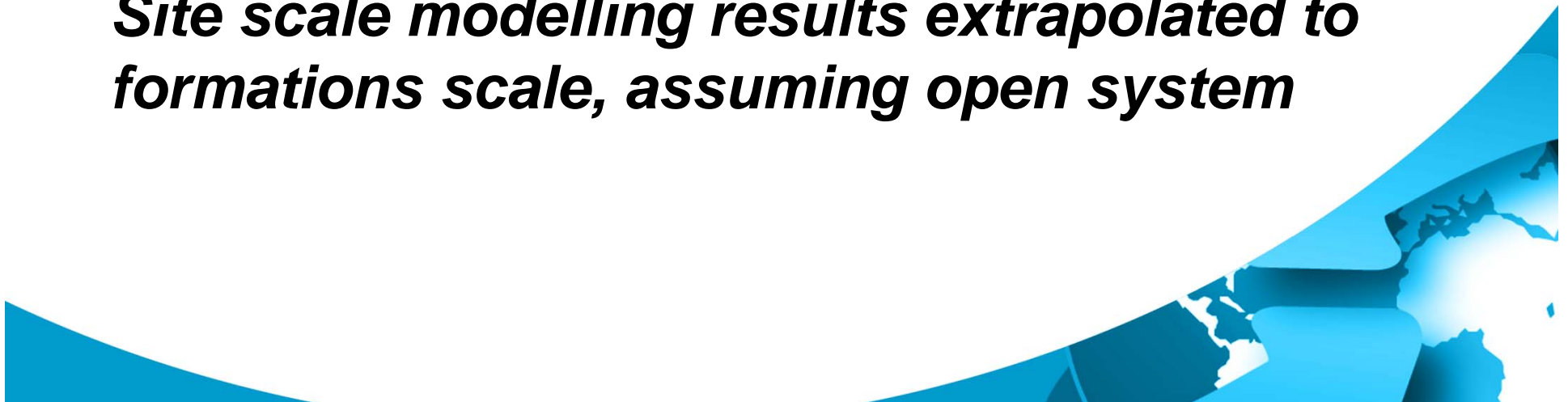


***Approximately 200 simulations run with statistically-derived heterogeneous models***

***Coefficients derived for separately for 3 lithologies***

***Structural setting found to exert biggest influence on storage efficiency at site scale***

***Site scale modelling results extrapolated to formations scale, assuming open system***



# Coefficients for Effective Formation Resources



Lithology	Storage Coefficients (%) by probability percentile		
	P10	P50	P90
Clastics	1.9	2.7	6.0
Dolomite	2.6	3.3	5.5
Limestone	1.4	2.0	3.3
All	1.7	2.6	5.1

# Expert Review



***Reviews received on draft report from 11 experts; many detailed technical comments***

## ***Some key observations/queries:***

- Better explanation of applicability to projects;
- Clearly explained relationship to classification;
- Further discussion of scale issues;
- Significance of onshore versus offshore;
- Sensitivity to injection rate assumptions

# Conclusions

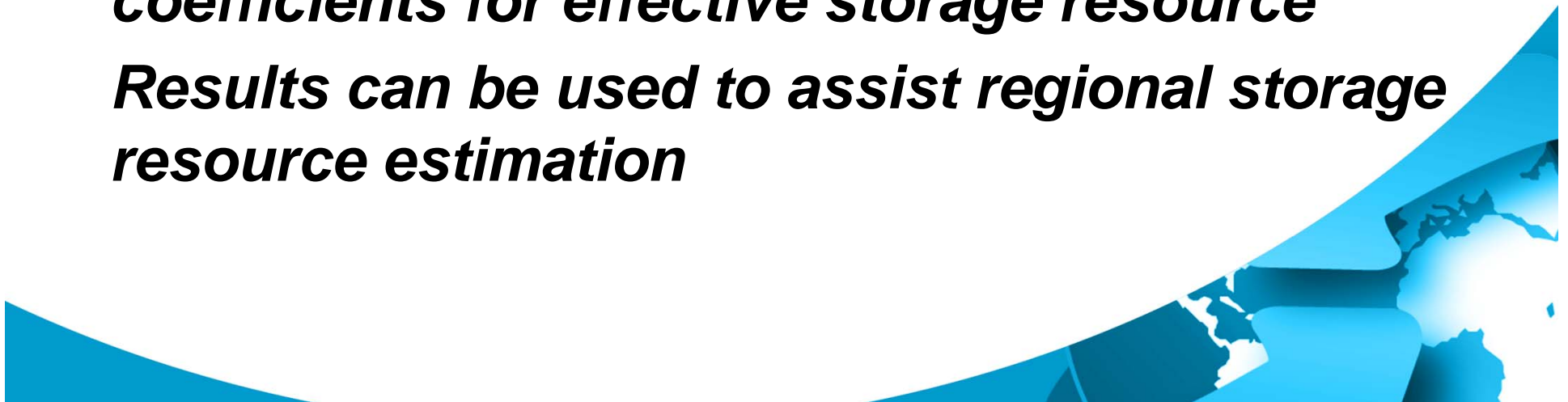


***Study concentrated on CSLF/US DOE methods applied to deep saline formations***

***DSF properties represented by database constructed from hydrocarbon field data***

***Modelling showed influence of various factors on storage efficiency and allowed derivation of coefficients for effective storage resource***

***Results can be used to assist regional storage resource estimation***





# Recommendations



***The analysis and conclusions presented by the study are based on theoretical modelling. As experience and data is gained from increasing numbers of actual injection projects, the results of this study and the storage coefficients derived should be reassessed at an appropriate point in the future using real-world data. This could form the basis of a future IEA GHG study.***

