Global Status of CCS and Crossborder Cooperation

Millie Basava-Reddi, John Gale and Tim Dixon, IEAGHG

CGS Europe Workshop 'CO_2 Capture and Storage in the Baltic Sea Countries'; Espoo, May 2013

IEA Greenhouse Gas R&D Programme

- A collaborative international research programme founded in 1991
- Aim: To provide information on the role that technology can play in reducing greenhouse gas emissions from use of fossil fuels.
- Focus is on Carbon Dioxide Capture and Storage (CCS)
- Producing information that is:
  - Objective, trustworthy, independent
  - Policy relevant but NOT policy prescriptive
  - Reviewed by external Expert Reviewers
- Activities: Studies and reports (>250); International Research Networks: **Risk, Monitoring, Modelling, Wells, Oxy, Capture, Social Research, Solid Looping**; GHGT conferences; IJGGC; facilitating R&D and demonstrations eg Weyburn; Summer School; peer reviews.


BG GROUP
bp
CEZ GROUP
Chevron
eni
TOTAL
EPRI
ALSTOM
ExxonMobil
CIAB
Schlumberger
ConocoPhillips
Doosan Babcock
SCOTTISHPOWER
EnBW
REPSOL YPF
e·on
VATTENFALL
Masdar CARBON
INSTITUTO DE INVESTIGACIONES ELECTRICAS
B&W power generation group
Enel L'ENERGIA CHE TI ASCOLTA.
GLOBAL CCS INSTITUTE
JGC
RWE The energy to lead
Statoil
Evaluating technology options to mitigate greenhouse gas emissions
ieaghg

IEAGHG Activities

- Task 1: Evaluation of technology options
  - Based on a standard methodology to allow direct comparisons and are peer reviewed
- Task 2: Facilitating implementation
  - Provision of “evidence based information”
- Task 3: Facilitating international co-operation
  - Knowledge transfer from existing, laboratory, pilot and commercial scale CCS projects globally
- Task 4:To disseminate the results as widely as possible.

International Research Networks

Capture

- Post combustion capture
- Oxyfuel combustion
- Chemical Looping

Storage

- Risk management
- Environmental impacts
- Well bore integrity
- Modelling
- Monitoring

Cross Cutting

- ***CCS costs***
- ***Public awareness/social research***

CCS Global Developments

- Significant R&D and Deployment Activity
  - USA, Canada, China, Korea, Japan
  - Europe (UK, Spain, Netherlands) & Norway, Australia
- Significant Deployment Interest Developing
  - Gulf States, Romania
- Significant R&D but Deployment Stalled
  - Germany, Italy, France, Poland
- Significant R&D Underway
  - Brazil, Mexico, South Africa, Taiwan
- R&D Programmes in Developing Countries
  - India, Indonesia

CO_2 Injection Pilots

What do pilots contribute?

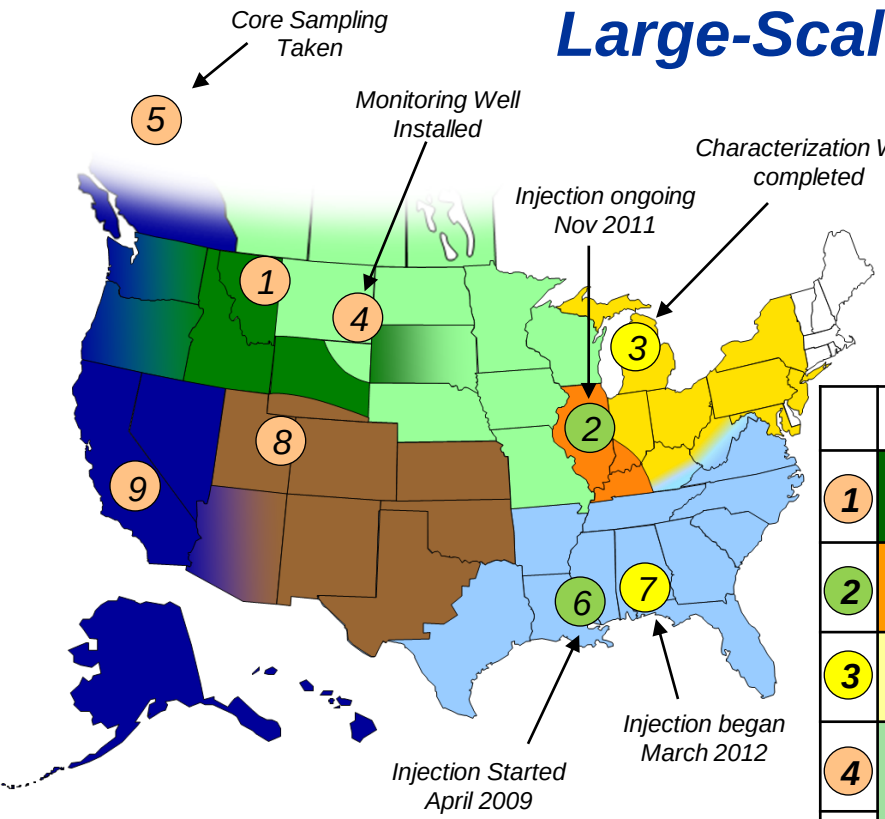
- In the absence of demonstrations they are key
- Geological data/Knowledge
- Monitoring and Operational experience
- Evidence to build case for storage security
- Public interface/confidence building
- The pilot operators are the REAL experts

USA

- Regional Carbon Sequestration Programme
  - Characterization Phase (2003-2005): region's potential to store CO_2 in different geologic formations.
  - Validation Phase (2005-2011): Evaluation of promising CO_2 storage opportunities through a series of small-scale (<500,000 metric tons CO_2) field tests to develop understanding of injectivity, capacity, and storability of CO_2 in the various geologic formations
  - Development Phase (2008-2018+): Implementation of large-scale field testing involving at least 1 million metric tons of CO_2 per project.

RCSP Phase III: Development Phase

Large-Scale Geologic Tests



- ✓ *Injection Targets - minimum planned volumes*
- ✓ *Three ongoing RCSP Injection Projects*

	Partnership	Geologic Province	Storage Type
1	Big Sky	Sweetgrass Arch-Duperow Formation	Saline
2	MGSC	Illinois Basin-Mt. Simon Sandstone	Saline
3	MRCSP	Michigan Basin-St Peter SS or Niagaran Reef	Saline/Oil
4	PCOR	Powder River Basin-Muddy Formation	Oil Bearing
5		Alberta Basin-Sulphur Point Formation	Saline
6	SECARB	Interior Salt Basin-Tuscaloosa Formation	Oil/Saline
7		Interior Salt Basin-Paluxy Formation	Saline
8	SWP	Wasatch Plateau-Navajo Sandstone	Saline
9	WESTCARB	Regional Characterization	TBD

- *Injection Ongoing*
- *2012 Injection Scheduled*
- *Injection Scheduled 2013-2015*

Note: Some locations presented on map may differ from final injection location

Midwest Geological Sequestration Consortium

Decatur Site Large-Scale Project

Target Formation

- *Mt. Simon Sandstone*

CO_2 Source

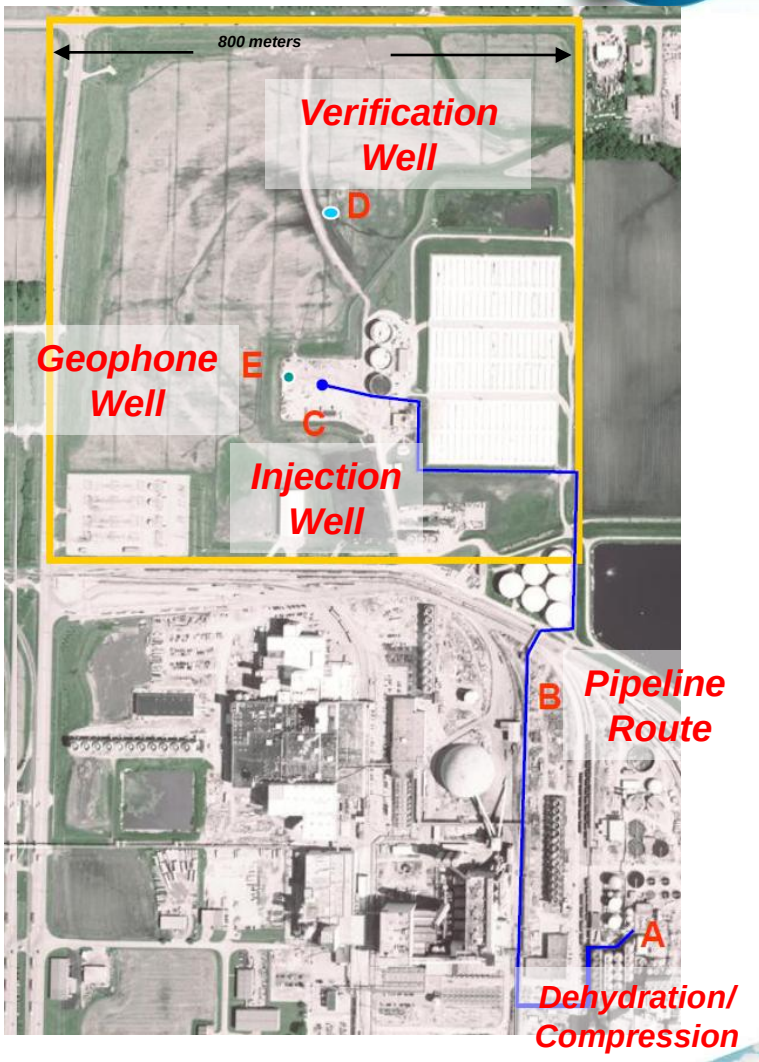
- *ADM's Ethanol Production Facility*

CO_2 Injection Amount

- *1 million metric tons over 3 years (Nov 2011)*

Current Status

- *Completed 4 square mile 3D seismic survey*
- *Completed drilling injection well, groundwater monitoring wells, geophone well, and verification well.*
- *CO_2 Pipeline installed and connected to injection wellhead.*
- *Installed all subsurface monitoring equipment.*
- *Completed commission of compression/dehydration facility*
- *Completed baseline fluid samples from verification well.*
- *Completed satellite interferometry (InSAR) baseline imaging data collection.*
- *UIC Permit finalized in March, 2011. Approval from IEPA to begin injection granted November 4, 2011.*
- *As of end November 2012 cumulative CO_2 injection volume is 286,000 metric tons*



Best Practice Manuals

- Monitoring, Verification, and Accounting (MVA) of CO_2 Stored in Deep Geologic Formations - 2012 Update
- Public Outreach and Education for Carbon Storage Projects
- Geologic Storage Formation Classification: Understanding Its Importance and Impacts on CCS Opportunities in the United States.
- Site Screening, Selection, and Characterization for Storage of CO_2 in Deep Geologic Formations NETL's
- Risk Analysis and Simulation for Geologic Storage of CO_2

Examples of pilot successes

- K-12 B, The Netherlands
  - Monitoring and operational experience used to develop permit application for ROAD project to EC.
  - First Injection/Monitoring permit approved by EC.
- Nagaoka, Japan
  - Monitoring after earthquake demonstrated that seismic activity did not impact storage security
  - Post closure monitoring demonstrated CO2 dissolution in reservoir brine

Examples of pilot successes

- Weyburn, Canada
  - Demonstrated importance of baseline monitoring
  - Alleged leak from site was disproved based on baseline monitoring
  - New technique by University of Texas based on soil gas ratio analysis in absence of baseline data
- Frio, USA
  - Demonstrated that when you leave the injection well open the CO_2 does not come back out of the formation.

Public Awareness

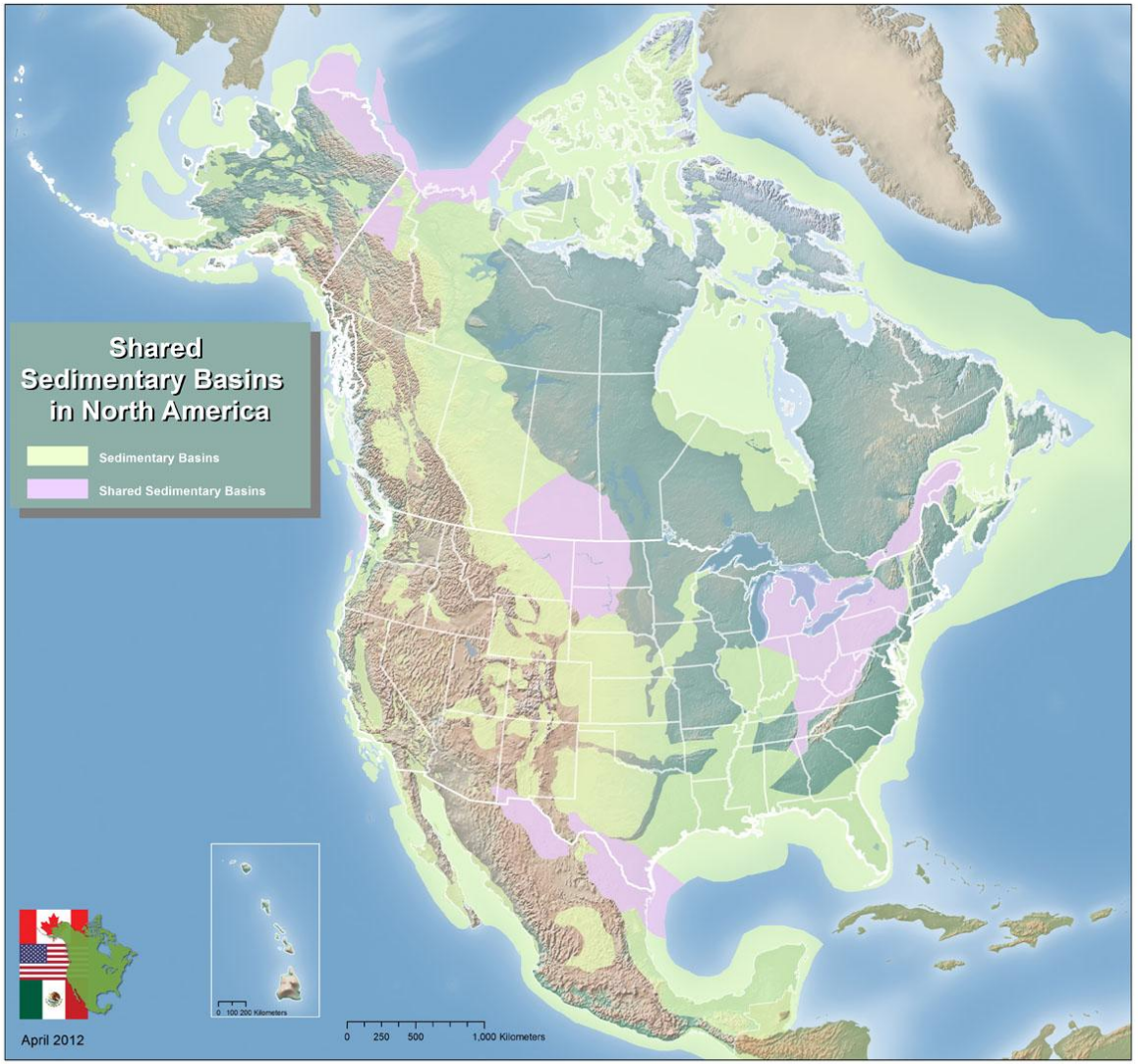
- Pilots play a key role
  - Visitor centres at sites
  - Direct local dialogue
  - First hand experience of CO_2 storage site
  - Meet the scientists
  - Disseminate information a local level
  - Build public confidence

Crossborder Cooperation

- Why this is important?
  - Geology does not stop at borders
  - Geological units can be mapped differently in different countries
  - Pressure effects can occur
- Examples:
  - NACSA Storage Atlas – Canada, USA and Mexico
  - Basal Cambrian – US/ Canada
  - North Sea, Bunter sandstone – UK/ Netherlands

NACSAP (North American Carbon Storage Atlas Programme

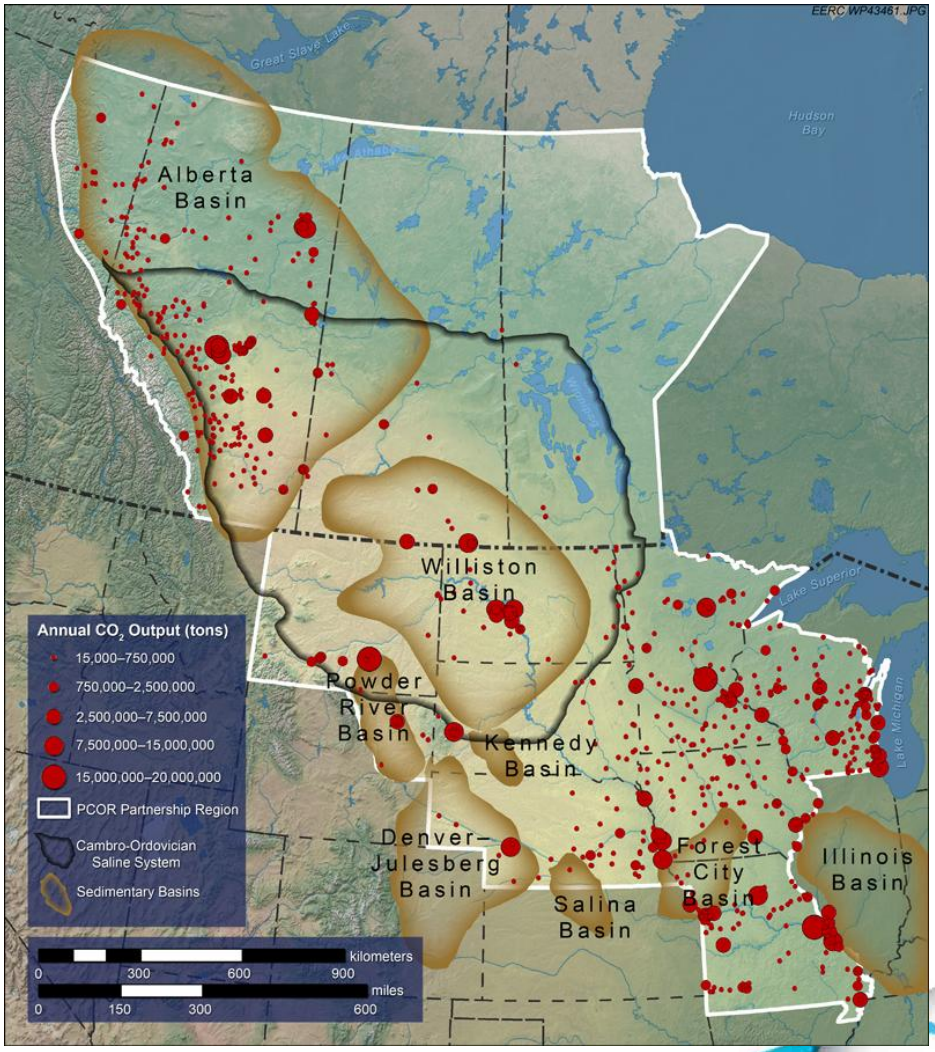
- Mapping collaboration project between Canada, USA and Mexico
- Specific country information
- Crossborder information – where possible
- Trilingual site
- www.nacsap.org



From NACSAP.org

US/ Canada Collaboration

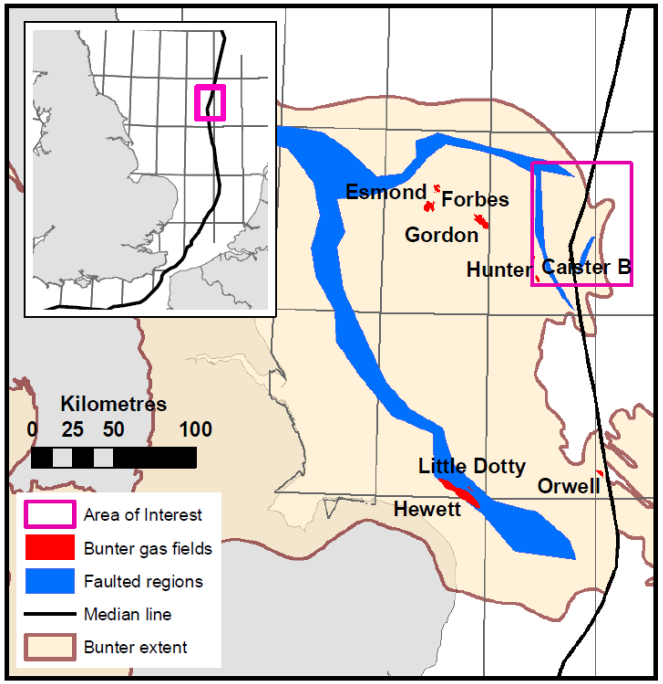
- Geological Characterisation of Basal Cambrian System
- Oldest layer of sed rock in region
- 300m thick, up to depths of 4400m
- Deep – rarely penetrated by drilling
- 3 year project started Oct 2010
  - Phase I - delineating & characterising Canadian and U.S. portions.
  - Phase II - 2-D model. Data on depth, thickness, and porosity collected - storage resource.
  - Phase III - will develop massive 3-D geologic model encompassing the entire study area

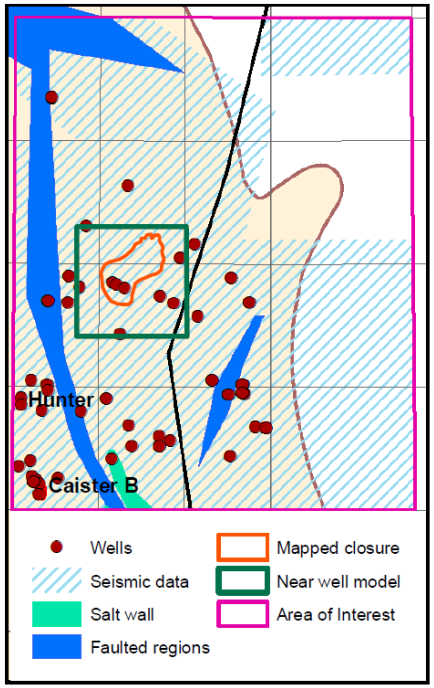


From undeerc.org

North Sea – UK/ Netherlands

- Bunter Sandstone Fm – regional saline aquifer
- 80 – 150 m thick
- Effects of CO_2 injection into 4 potential closures (UK) modelled
- Pressure footprint may extend into Netherlands territory
- Faults are potential migration pathways
- Therefore EIA and permitting may be needed for Netherlands as well as UK





From Hannis et al, GHGT-11

Transboundary Regulatory Issues

- London Convention
  - Prohibited CO_2 Transportation for purpose of 'dumping'
  - Amendments agreed 2012 to allow transport for CO_2 Storage
  - Needs to be ratified by 2/3 (28 countries) – 2 so far
- IPCC Guidelines for GHG Inventories (2006) provides guidance on responsibilities for emissions from transboundary CCS activities.
  - Includes 4 scenarios:
    1. CO_2 may be captured in one country, Country A, and exported for storage in a different country, Country B.
    2. CO_2 is injected in one country, Country A, and migrates from the storage site and leaks in a different country, Country B.
    3. More than one country utilizes a common storage site
    4. Storage site occurs in more than one country

A picture tells a 1000 words

Concluding Remarks

- CO_2 injection pilots are the key to global implementation of CCS.
  - Build science/knowledge base
  - Key to developing public confidence
  - Develop expertise for future larger scale implementation
- Crossborder cooperation important for formations and basins that cross borders/ hydraulically connected
- Regulations/ guidelines consider transboundary issues

Upcoming Network Meetings

- Combined Modelling and Risk Management Network Meeting
  - 10th – 13th June 2013
  - Hosted by Statoil in Trondheim, Norway
- Combined Monitoring and Environmental Research Network Meeting
  - 26th – 30th August 2013
  - Hosted by CO2CRC in Canberra, Australia
- Social Research Network Meeting
  - 14th – 15th January 2014
  - Hosted by University of Calgary, Calgary, Canada

Thank you, any Questions?

ludmilla@ieaghg.org
www.ieaghg.org