IPCC SRCCS – 10 years later

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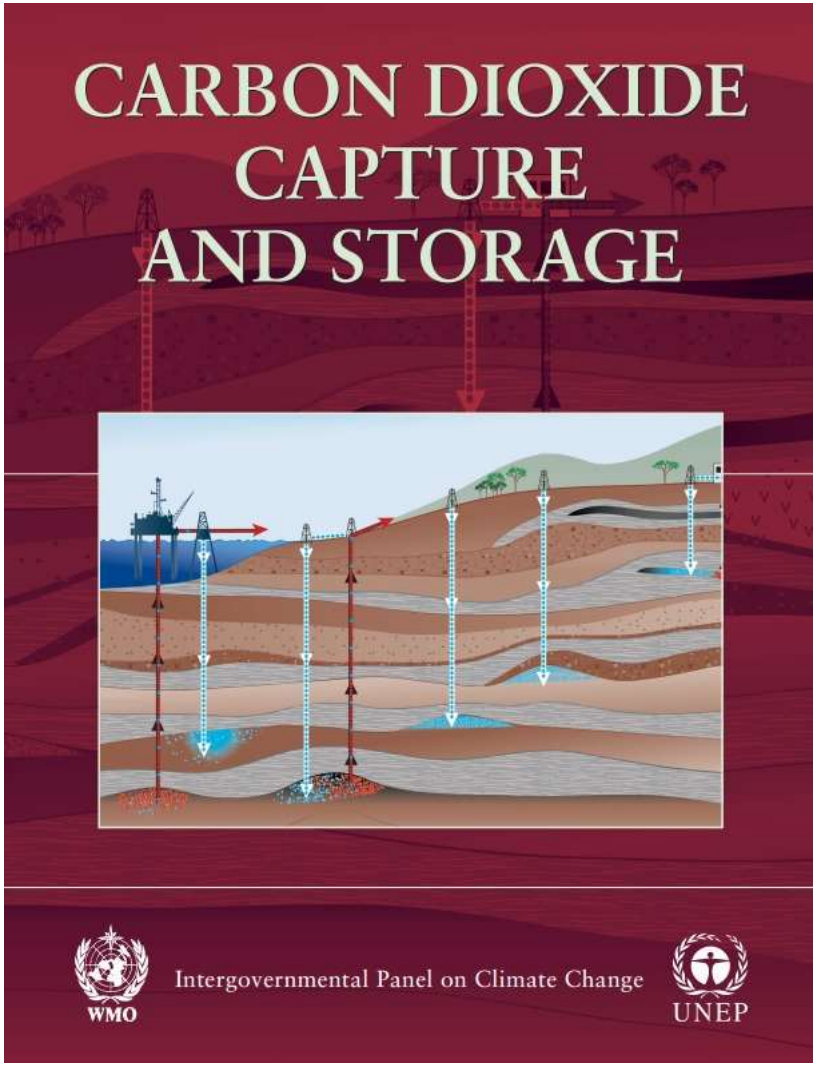
CCS AT A CROSSROADS

21 & 22 October 2015 Cambridge, MA, USA

IPCC SRCCS 2005



- Significant contribution to CCS deployment
- Lead to CCS being accepted by UFCCC as a mitigation option.
- Set out technical status of CCS as of 2005
- Two CCS projects:
  - Sleipner
  - IEAGHG WeyburnCO_2 Monitoring and Storage

IJGGC Special Issue No. 40

- Updates IPCC SR on CCS
- 17 technical papers on CCS progress
- Take away message:

"Considerable progress made in all areas in the last ten years"

- http://www.sciencedirect.com/science/journal/17505836/40
- Papers free to download until 31st Dec 2015

IJGGC Special Issue No. 40

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- Excluded:
  - System modelling – now in Assessment reports
  - Emissions Accounting - IPCC Guidelines 2006
  - Ocean storage – research curtailed
  - Mineral carbonation – niche application limited progress on key issues
  - CO_2 Utilisation - new separate journal
    - Question if this is mitigation or emissions leakage??
  - CO_2 transport – gap to be filled
  - CCS safety – paper dropped out

CO_2 Capture (PCC[1])

- PCC was mature in industry at time of IPCC SRCCS
- Significant advances in scale up in 10 years
- Boundary Dam 3 first power sector demonstration of PCC
- Significant progress on development of new solvents/solvent based processes
- Improvements in absorber design/modelling and simulation will feed into future PCC developments

1 - Post Combustion Capture

CO_2 Capture – Oxy fuel

- Significant advances in last ten years
- Demonstration now required
  - White Rose project in UK
- Could be well suited to industrial applications
  - Not considered in SRCCS
- Emerging as an option for CO_2 capture in gas fired cycles
  - High efficiencies, compact plant size

CO_2 Capture (IGGC[2])

- Uses commercially proven equipment
- First demonstration close
  - Kemper County, USA late 2016
- Can be deployed in industrial applications
  - Chemical production and iron and steel
- Alternate configurations of water gas shift process a key R&D topic

2 – Integrated Gasification Combined Cycle/ Pre combustion capture

CO_2 capture – novel systems

- Substantial body of technical literature published
- Potential for cost savings and reduced energy penalties
- Technical readiness increased
  - Calcium looping, Ca looping, solid sorbents and polymeric membranes
  - Require technical proofing at pilot scale and above

CO_2 Storage

- Significant progress in knowledge base on deep saline formations
- Limited progress on CO2-ECBM
- Storage in shales an emerging topic
- Injection projects in gas and oil fields largely involved monitoring developments
- CO2-EOR
  - IEAGHG Weyburn-Midale CO_2 Monitoring and Storage Project had its own SI in 2013
    - IJGGC Vol. 16 Supplement 1, pages S1-S308 (June 2013)

CO2 Storage

- Subjects where most progress made and have dedicated papers:
  - Storage efficiency,
  - CO_2 plume and pressure evolution,
    - Unknown topic in SRCCS
    - Pressure management strategies now exist
  - Capillary trapping,
    - Substantial knowledge base developed
    - CO_2 will occupy at least 10% but more likely 30% of the pore volume
    - Leads to plume immobilisation and storage security
  - Convective mixing and CO_2 dissolution
    - Increase storage security – dissolved CO_2 no longer n buoyant
  - Subsurface geochemical effects
- Summary – CO_2 storage is a safe operation if storage sites properly selected, characterised and managed

Environmental Impacts of CCS

- Significant developments
  - Natural analogue studies
  - Large number of recent controlled release experiments
- Major conclusion:
  - Environmental impacts are usually in the form of small isolated areas
  - Organisms have demonstrated some ability to adapt
- Artificial leaks have shown that surface expression may be some distance from the source
  - Locating leaks may not be easy
- Ground water contamination an issue
  - Impact is expected to be limited
  - Monitoring ground water systems is probably not a good leak detection option.
- Better definition of leakage scenarios and fluxes is still required.

Monitoring of CCS impacts

- Significant progress made in deep focused monitoring techniques
  - Nearly 20 years of data from Sleipner
- Shallow focused monitoring has been extensively deployed
  - Important role in Weyburn test case
- Better predictive leakage monitoring is needed otherwise nil results from shallow monitoring are difficult to interpret

CCS Risk Assessment

- Now a mature field
- Well bore integrity a key technical risk
  - Old wells are a major issue in regions of the world
- New technical risk has emerged induced seismicity
  - Increased public awareness due to shale gas in USA
  - No issues from existing CCS projects
- Mitigation options remains a gap
  - In part reflects lack of credible mechanisms for a major containment loss
  - Mitigation options mostly modelled.

Economics of CCS

- CCS needs to be cost competitive with other low carbon technologies
- Costs have not changed significantly since the SRCCS
- One key conclusion:
  - As yet no clear technological winner
  - Considerable overlap between published costs
    - Significant regional variations

Bio-CCS

- Focus of interest since the SRCCS
  - Potential for negative emissions
- IPCC 5th Assessment report covered Bio-CCS extensively
- Actual Bio-CCS projects
  - Illinois Decatur Project in USA
- A significant barrier - accounting frameworks do not recognise/reward negative emissions
- Complex links between; food, water, energy and climate need to be resolved.

CCS Policy

- Maritime treaties were main focus of SRCCS
- Restrictions in marine treaties removed in 2006/7
- CCS Specific laws now drafted in : EU, USA and Australia
- CCS included in the UNFCCC's Clean Development Mechanism in 2011

Public Acceptance

- Little information on topic in SRCCS
- Now an extensive database of published material includes:
  - Case reviews, tool kits, best practise guidelines
- Considerable progress on how to communicate
- In general public level of awareness same as at time of SRCCS
- Significant developments around actual CCS projects

Summary

- The science and technology underpinning CCS has advanced greatly in the last 10 years
- Underlines the fact that CCS is ready for large scale deployment
- Several demonstration projects underway or close to start up
- Costs will decrease as leading technologies are deployed
- Emerging technologies show promise but need scale up and “proving” at an industrial scale

Challenge to all to fill gaps

- Thrown out challenge to readers/authors to fill in gaps
  - Submit an idea and a paper
- Virtual Special Issue planned in 2 or 3 years time.
- One gap in knowledge already filled
  - Virtual Special Issue on Well Integrity
    - 32 papers submitted to journal
    - Compiled by Stefan Bachu of Alberta Innovates

Virtual Issue on Well Integrity

- Helps to close one gap in SRCCS SI update
- Compiled from 32 papers published in IJGGC
- Lead editor:
  - Stefan Bachu, Alberta Innovates, Canada

Virtual Issue on Well Integrity

- Two main conclusions
  - Properly completed wells will retain their integrity in contact with CO_2-saturated brine
  - Wells with pre-existing flow conduits, such as de-bonded interfaces and cement fractures, may further lose their integrity or may self-seal.
- Issue can be found at: http://www.journals.elsevier.com/international-journal-of-greenhouse-gas-control/virtual-special-issues/well-integrity-in-co2-storage-in-deep-saline-aquifers/