



CCS: 10 Years of Progress and a Bright Future?

John Gale

General Manager

IEA Greenhouse Gas R&D Programme

Climate Change Mitigation:

Making Progress in Difficult Times

DIQA – University of Sevilla, Spain

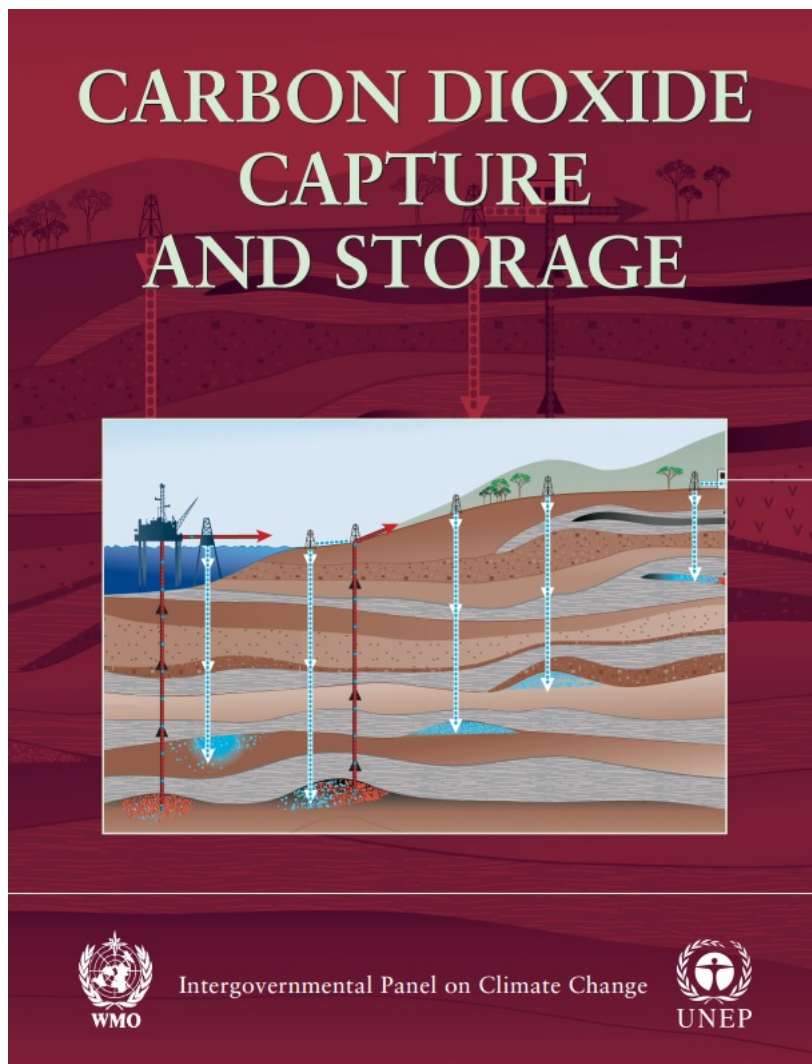
May 4th 2016

CCS: 10 Years of Progress and a Bright Future?



- Overview of talk
 - Starting point the IPCC SRCCS 2005
 - Learnings 10 years on
 - Look at key developments occurring in 2016/2017
 - Review COP21 outcomes for CCS
 - Cast forward to 2030 and Beyond

IPCC SRCSS 2005



- **Significant** contribution to CCS deployment
- Lead to CCS being accepted by UNFCCC as a mitigation option.
- Set out technical status of CCS as of 2005
- Two CCS demo. projects:
 - Sleipner
 - IEAGHG WeyburnCO₂ Monitoring and Storage

IJGGC Special Issue No. 40



- Updates IPCC SR on CCS
- Updates underpinning science 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>

CCS Policy



- Maritime treaties were main focus of SRCSS
- 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

CO₂ Capture (PCC)



- 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



CO₂ Capture – Oxy fuel

- Significant advances in last ten years
- Demonstration now required
 - White ~~X~~se, UK,
 - Most likely now in China
- Emerging as an option for CO₂ capture in gas fired cycles
 - High efficiencies, compact plant size, water producer not consumer
 - NETpower started construction of 50MWth demo.

CO₂ Capture (IGGC²)



- 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

CO₂ 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

CO₂ Storage & Monitoring



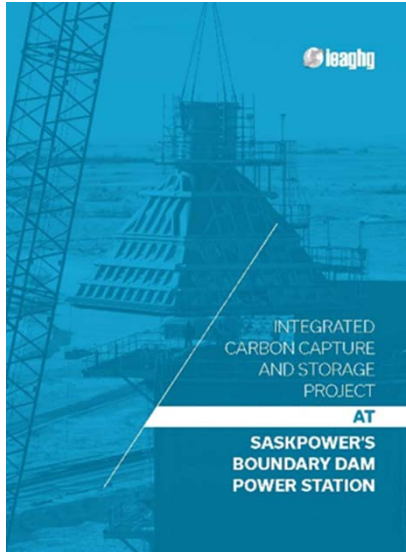
- Significant progress in knowledge base on deep saline formations
 - Other formations limited info.
- CO₂ storage is a safe operation if storage sites properly selected, characterised and managed
- Significant progress made in deep focused monitoring techniques
 - Nearly 20 years of data from Sleipner
- Shallow focused monitoring has been extensively deployed
 - Important role in Weyburn test case
- Main containment risk is well bores
- Environmental impacts are usually in the form of small isolated areas



Bio-CCS

- Focus of interest since the SRCSS
 - 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.

Boundary Dam 3 Developments



- First years learnings captured in report
- First of a kind plant
- Learning curve for company
- A lot of bad press
- Cost savings of 30% on CAPEX and 25% on OPEX identified

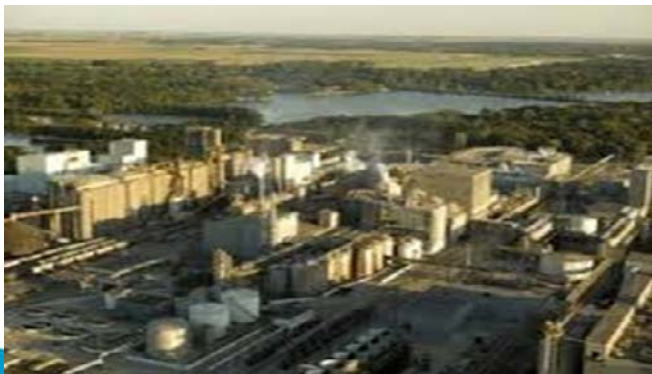


- In March 2016 update on the status
- 1st qtr. 2016, the overall reliability factor was 90 per cent.
 - 83,497 tonnes of carbon dioxide were captured in March 2016,
 - 217,000 tonnes have been captured so far this year
 - The process on its way to meeting its 2016 target of 800,000 tonnes

Projects just on stream



New Developments 2016/17



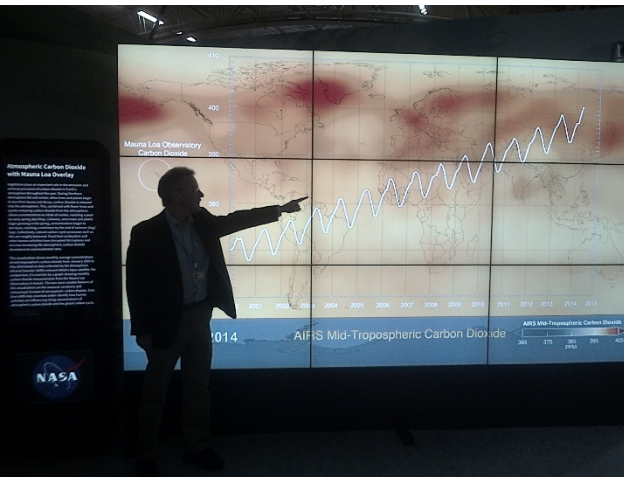
 **3. Progress of CO₂-EOR project**
(3) JingBian CO₂-EOR pilot



COP-21 Paris



Photo courtesy IISD/ENB





Climate Action Now

Summary
for Policymakers
2015



United Nations
Climate Change Secretariat

- **‘Climate Action Now’
UNFCCC - 18 Nov 2015**
- High level summary of policy actions with high mitigation potential at 2020
- Builds on Technical Expert Meetings (TEMs)
- Includes CCUS as one of the six priority areas
- Significance of Boundary Dam CCUS project
- Solutions through international cooperation – eg IEAGHG, CSLF, GCCSI



Intended Nationally Determined Contributions (INDCs)

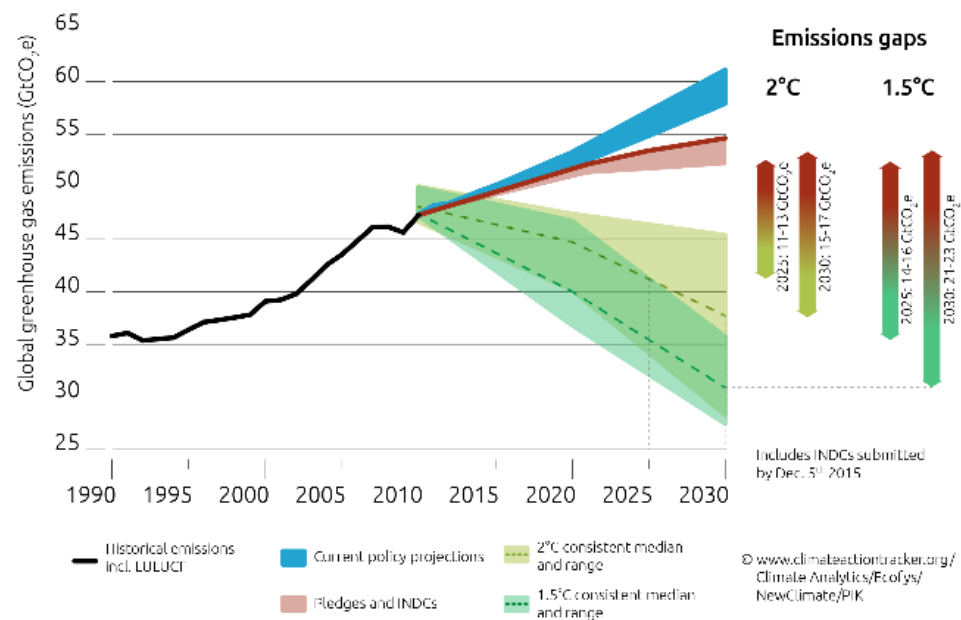
- 187 INDCs submitted
- 94% global emissions
- New trajectory to ~ 2.7C
- ~ 3.6C from existing policies

CCS in 10 INDCs

- | | |
|---------|--------------|
| Bahrain | Malawi |
| Canada | Norway |
| China | Saudi Arabia |
| Egypt | South Africa |
| Iran | UAE |
| | (and EU) |

CAT Emissions Gaps

7th December 2015

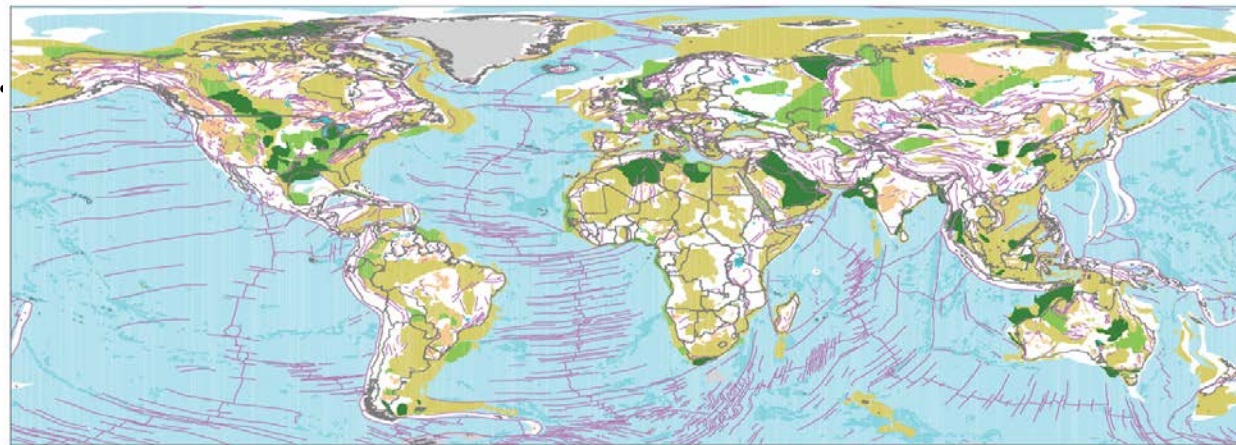


Climate Action Tracker
<http://climateactiontracker.org/global/173/CAT-Emissions-Gaps.html>

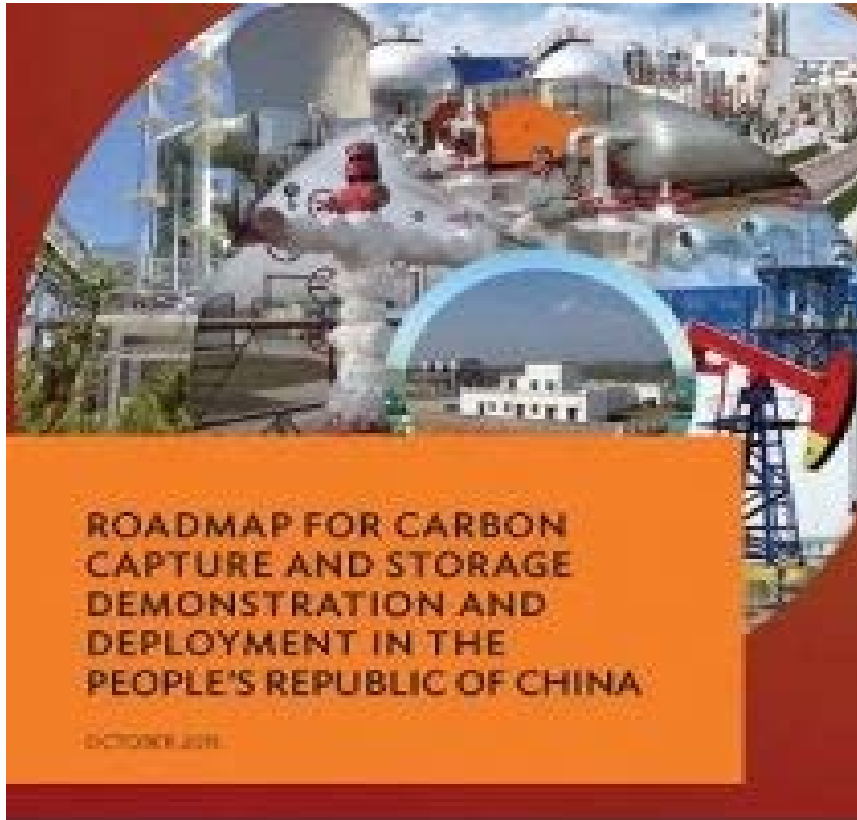
What Next?



- A lot of work to develop the details to implement the Paris Agreement - especially the 'Technology Framework' - starting in SBSTA-44 (May 2016) and COP-22 Marrakech (7-18 Nov 2016)
- IPCC to examine 1.5C scenarios – Special report by 2018
- Further TEMs
- NDCs updated.....



A Key Developments



- NDRC key Chinese Ministry
- 2 stage process for CCS
- Up to 2030
 - R&D emphasis
 - Deployment in industry with CO₂-EOR
 - Fertilisers/chemicals, CTL
- After 2030
 - Deployment in power sector

CCS going forward



- Up to 2030
 - Continued deployment of CCS with industry leading
 - Financial support provisions
 - Infrastructure development/financing
 - Expansion of knowledge base “learning by doing”
 - Help demonstrate technology credibility and “de-risk CCS in financiers minds
 - Testing at scale and “proving” of novel capture technologies
 - Proving geological resource outside of EU/NA

CCS going forward



- Need to have done ground work to accelerate CCS deployment
 - Developed and developing countries
- Negative emissions technologies
 - If we miss early mitigation targets
 - Deep concern
 - Political will and Action not always consistent !!!
 - Many developing countries still relying on coal for domestic energy production
 - Only way to use this is with CCS !!
 - » Higher efficiency on its own is not enough

IEAGHG et al Side-event



Carbon Capture and Storage (CCS): Achievements and Opportunities for Developing Country Involvement, 1st December 2015



Tim Dixon, IEAGHG

Mike Marsh, President Saskpower

Philip Ringrose, Statoil

Ton Wildenborg, CO2GeoNet

Jukka Uosukainen, CTCN

Katherine Romanak, University of Texas

Brad Wall, Premier of Saskatchewan

IEAGHG et al Side Event



Outcomes



- 200 attendees
- Messages:
 - Philip Ringrose, Statoil, 19 years of Sleipner
 - Mike Marsh, CEO, SaskPower Boundary Dam 3 and hopes to capture 800 kt CO₂ in 2016.
 - Ton Wildenborg, CO₂GeoNet, CO₂ storage projects in Europe
- Reported at: www.ieaghg.org & <http://www.iisd.ca/climate/cop21/enbots/1dec.html#event-6>
- Generated a lot of discussion and attendance at booth in “Blue Zone”

Summary



- As a technology CCS has come along way
- Not an easy technology for financiers to understand – many components/high risk
- CCS momentum is building
- $>2^{\circ}\text{C}$ target increases need for CCS
- The future for CCS is rosy