



Key Developments in CCS- & **Saskatchewan's Input**

John Gale

General Manager

IEA Greenhouse Gas R&D Programme

2015 SaskPower CCS Symposium

Regina, Saskatchewan, Canada

10th September 2015

The IEA Greenhouse Gas R&D Programme?



Part of the IEA ETN since 1991



32 Members from 18 countries plus OPEC, EU and CIAB

What We Are:



Members set strategic direction and technical programme



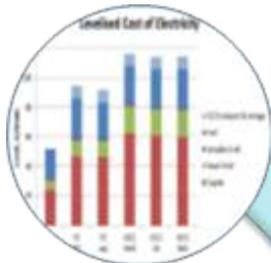
Technical based organisation

- We don't define policy
- We are not advocates

What do we do?



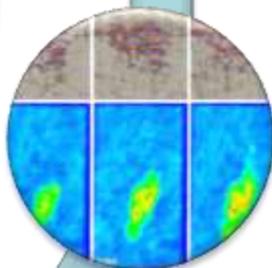
Assess All Mitigation Options –
Focus our R&D CCS



Track Capture Technology
Developments/Costs



Monitor Geological
Storage Performance



Provide Members and Policy
Audience with Independent
Technical Input



Our Core
Activities
Are:



ALSTOM

CIAB

EnBW

ExxonMobil

Masdar CARBON



ieaghg



EPRI

JÜLICH FORSCHUNGSZENTRUM

DOOSAN Ocean Bunkers

Statoil



BR PETROBRAS

INSTITUTO DE INVESTIGACIONES ELECTRICAS

JGC

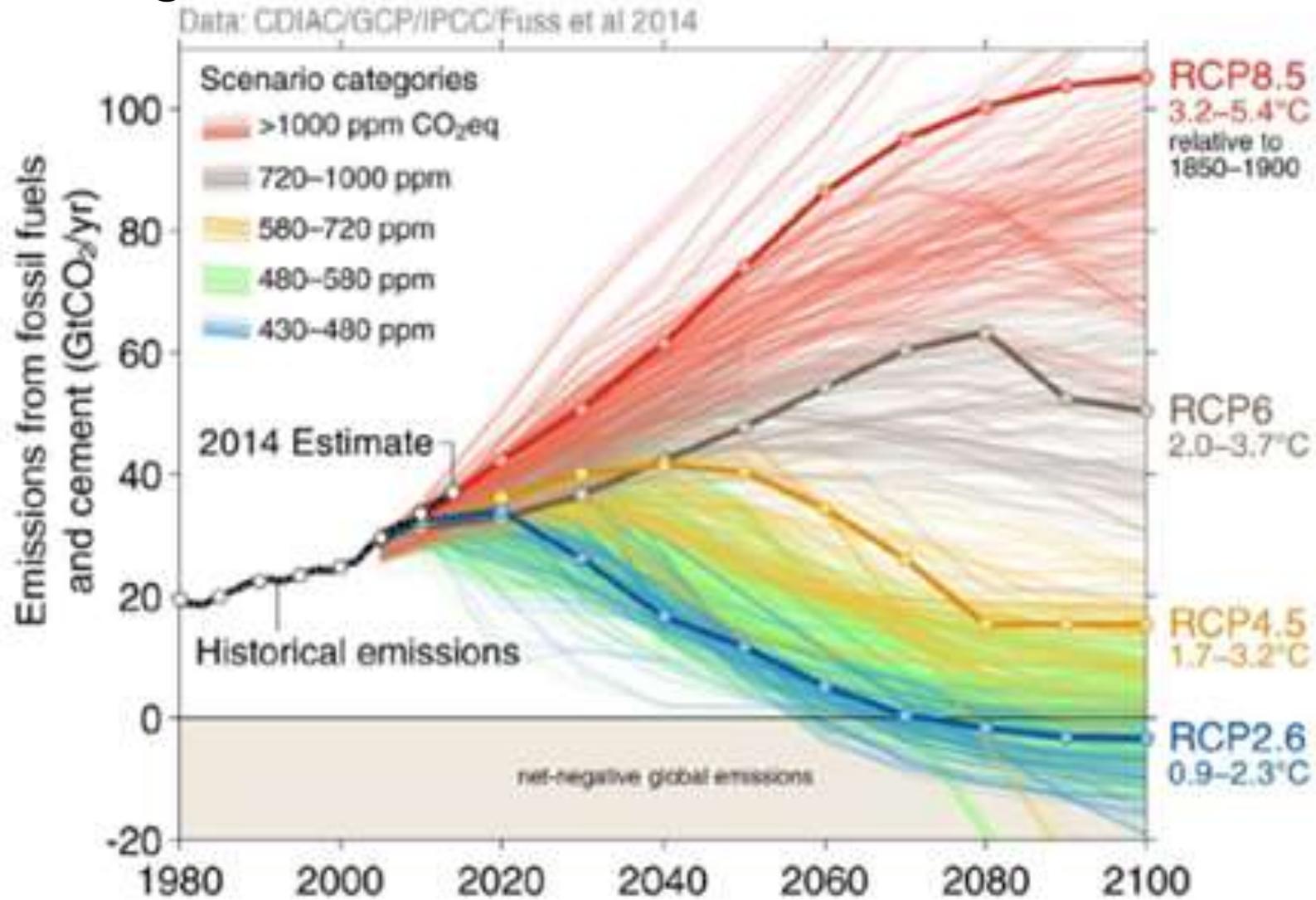
RWE The energy to lead



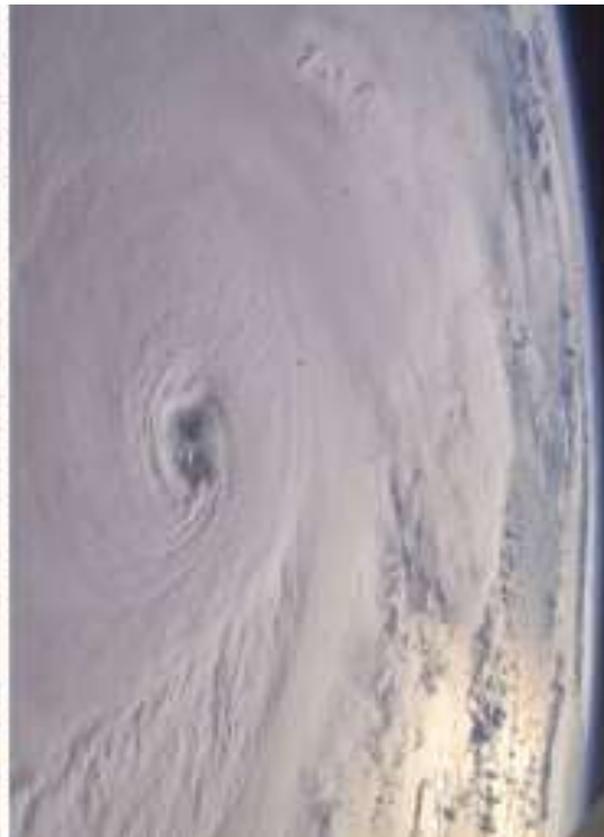
United Nations Framework Convention on Climate Change



Why are we here?



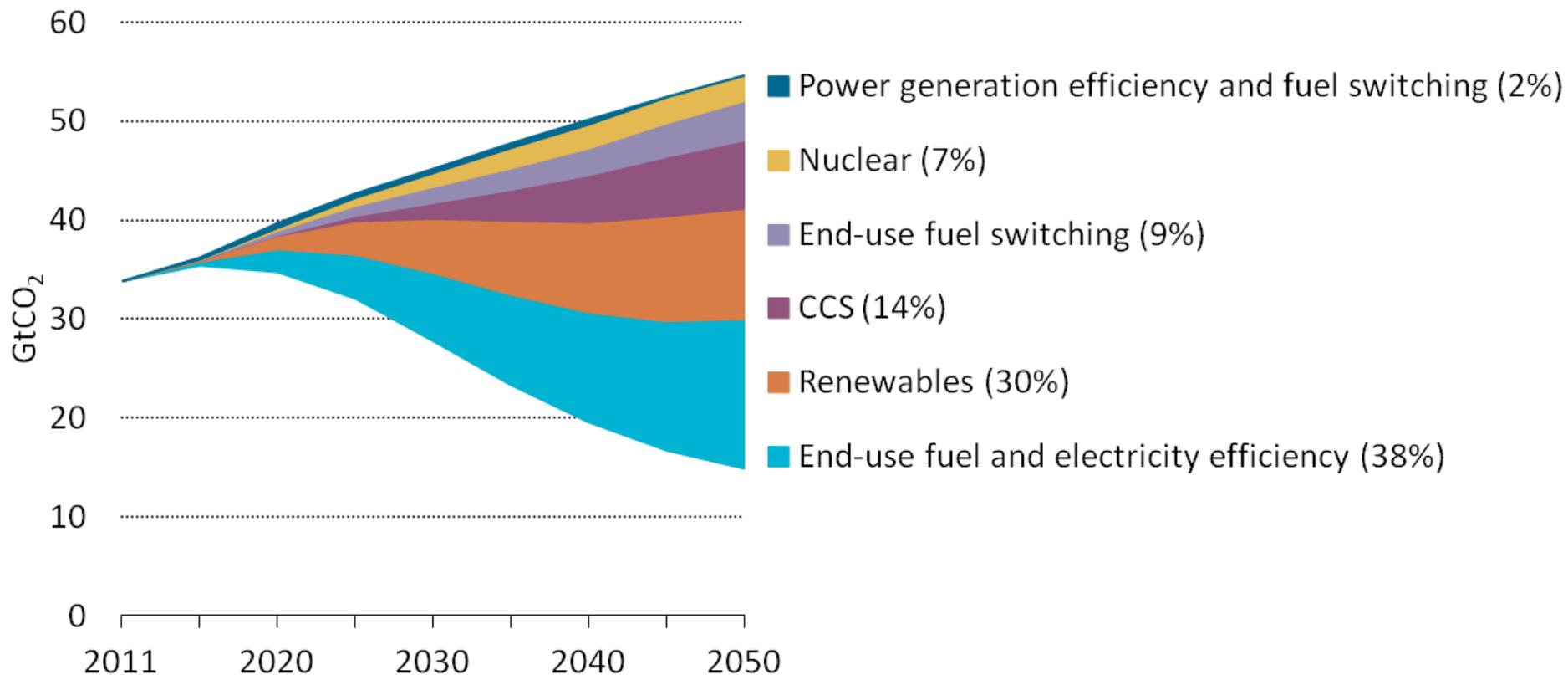
Consequences of not making the 2DS



The potential future effects of global climate change include more frequent wildfires, longer periods of drought in some regions and an increase in the number, duration and intensity of tropical storms. Source: <http://climate.nasa.gov/effects/>



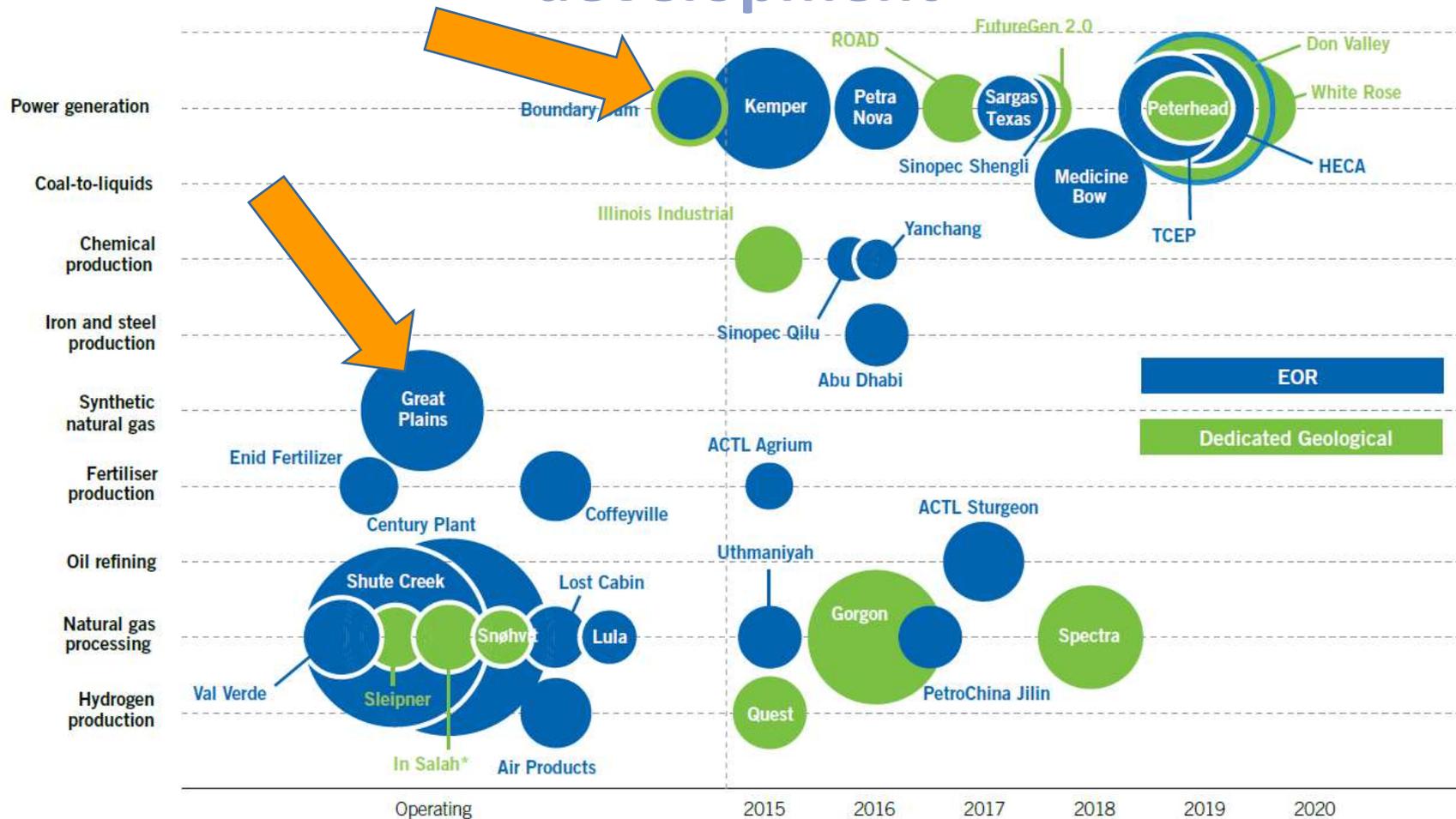
CCS is one of the key technologies to tackle climate change



Carbon capture and storage (CCS) contributes 14% of total emissions reductions through 2050 relative to the IEA 6DS scenario



Around a dozen projects are at earlier stages of development



○ = 1Mtpa of CO₂ (area of circles proportional to capacity)

Source: GCCSI 2014

* Injection currently suspended

ETP2015 – Tracking Energy Progress



- CCS not on track – positive developments (BD3)
- **CCS deployment has begun in “sweet spots”** where policies and strategic local and commercial interests align
- **“Learning-by-doing”** is now also under way for CCS in power generation.
- Widespread deployment requires the cost gap be closed by determined, parallel action in technology development and market creation.
- Improving and using post-combustion technologies is of particular importance

Sharing knowledge has been key to CCS advancement



Key Knowledge Deliverables



- IPCC Special **Report** on CCS (2005)
 - CCS can be a large-scale mitigation option
- OSPAR **Report** on Ocean Acidification (2006)
 - Helped bring about inclusion of CCS in OSPAR and London Convention
- UK DTI/BERR **Reports** on CCS in ETS (2004-2007)
 - Helped bring about inclusion of CCS in EU ETS
- IPCC GHG Inventory **Guidelines** (2006)
 - Created methodology for GHG performance of CCS – basis for all CCS regulations
- UNFCCC Technical **Workshop**, Abu Dhabi (2011)
 - Helped get CCS in CDM by addressing issues of concern directly with negotiators
- UNFCCC ADP TEM and COP **Side-Event** on CCS Projects (2014)
 - An appreciation in UNFCCC of the reality of large-scale CCS projects
- IPCC AR5 (2014) – see later



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE
Working Group III: Mitigation of Climate Change



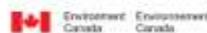
WORKSHOP ON CARBON DIOXIDE
CAPTURE AND STORAGE

PROCEEDINGS

Regina, Canada, 18-21 November 2002

Published by ECN

Sponsored by:



Disclaimer:
Supporting material prepared for consideration by the Intergovernmental Panel on Climate Change. This supporting material has not been subject to formal IPCC review processes.



IEAGHG
WEYBURN-MIDALE
CO₂ MONITORING
AND STORAGE PROJECT





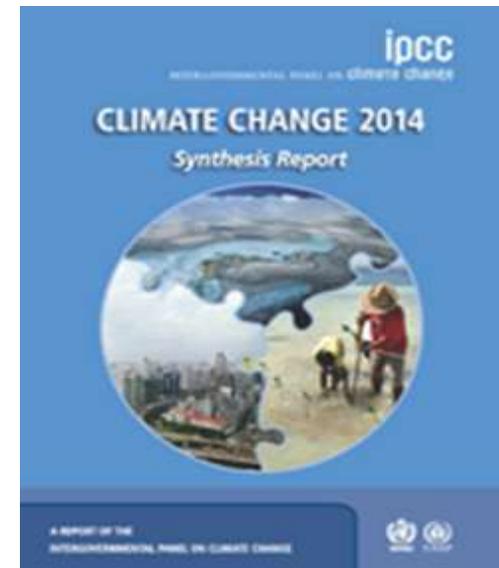
What to read before Paris?



IPCC AR5 Synthesis Report



- “the most comprehensive assessment of climate change yet undertaken”
- “The risks of climate change and its impacts are immense and should be of great concern to all”
- “Human influence on the climate system is clear”
- “Energy production remains the primary driver of GHG emissions”



<http://www.ipcc.ch/report/ar5/syr/>

IPCC AR5 Synthesis Report



- Global climate models
 - Removing CCS from the mix will increase mitigation costs by a **massive** 138%.
 - Many models cannot reach concentrations of about 450 ppm CO₂eq by 2100 without CCS
- Benefits for fossil fuel producers
 - **“the availability of CCS would reduce the adverse effects of mitigation policies on the value of fossil fuel assets”**

IJGGC Special Issue No. 40



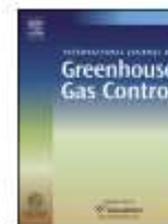
- Updates IPCC SRCCS
- 17 technical papers on CCS progress
- Take away message:
“Considerable progress made in all areas in the last ten years”
- <http://www.sciencedirect.com/science/journal/17505836/40>
- Papers free to download until 31st Dec 2015



Contents lists available at ScienceDirect

International Journal of Greenhouse Gas Control

journal homepage: www.elsevier.com/locate/ijggc



Practical experience in post-combustion CO₂ capture using reactive solvents in large pilot and demonstration plants



Raphael Idem^{a,*}, Teeradet Supap^a, Huancong Shi^a, Don Gelowitz^a, Max Ball^b,
Colin Campbell^b, Paitoon Tontiwachwuthikul^a

^a Clean Energy Technologies Institute, University of Regina, 3737 Wascana Parkway, Regina, Saskatchewan S4S 0A2, Canada

^b Saskatchewan Power Corporation, 2025 Victoria Avenue, Regina, Saskatchewan S4P 0S1, Canada



Contents lists available at ScienceDirect

International Journal of Greenhouse Gas Control

journal homepage: www.elsevier.com/locate/ijggc



Review

Recent progress and new developments in post-combustion carbon-capture technology with amine based solvents



Zhiwu (Henry) Liang^{a,f,**}, Wichitpan Rongwong^{a,d,f}, Helei Liu^a, Kaiyun Fu^a,
Hongxia Gao^a, Fan Cao^a, Rui Zhang^a, Teerawat Sema^{a,f}, Amr Henni^f, Kazi Sumon^f,
Devjyoti Nath^f, Don Gelowitz^f, Wayuta Srisang^f, Chintana Saiwan^{c,f},
Abdelbaki Benamor^d, Mohammed Al-Marri^d, Huancong Shi^f, Teeradet Supap^{c,f},
Christine Chan^{b,f}, Qing Zhou^{b,f}, Mohammad Abu-Zahra^e, Malcolm Wilson^{a,f},
Wilfred Olson^a, Raphael Idem^{a,c,f,*}, Paitoon (PT) Tontiwachwuthikul^{a,b,c,d,f,*}

Post Combustion Capture



- Already a mature technology in 2005 in industry
- Significant advancements in terms of scaling up in the last 10 years – BD3.
- R&D activity has led to the development of new solvent-based capture systems.
- Corrosion prevention strategies and analysis of solvent emissions are still active areas of R&D.
- Improved absorber design, accurate modelling and simulation of control procedures are now on going
 - These will further enable deployment of large-scale post-combustion units in industrial environments

IJGGC Special Issue No. 40



- A lot of positive feedback on the issue already

“Congratulations - this is an excellent special issue - I highly encourage others to download and read to gain some important insights from industry leaders in the current status of CCS technology”

Nigel Jenvey Chairman, CO₂ Capture Project

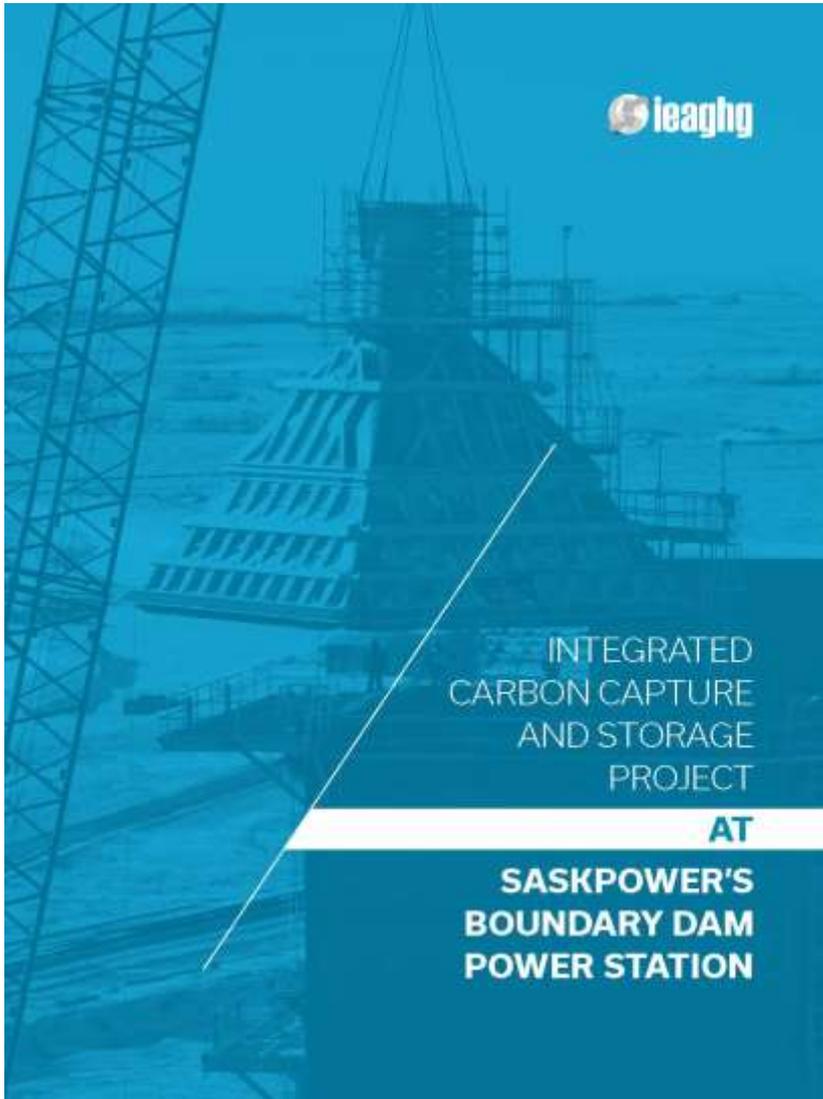
“based upon the work described in this compendium of papers, we are in a much better position to plan, execute and commercially deploy CCS technology”

Dr Carl Hustad, CO₂ Global

“Thanks to you and your colleagues at IEAGHG and to all the authors for this timely update”

Dr Martin Jagger, ADNOC

IEAGHG/SaskPower Report



- First operational power sector CCS project
- First summary report of **“learnings”** from an operational CCS project
- Latest in a series of co-operative activities going back over 10 years
- Pdf version mailed to all delegates
- Detailed presentation on report later.



What stands out for me !!

- SaskPower willingness to openly share their knowledge and experiences
- That the project was completed in the absence of regulatory guidelines
- That it was built at a time of very high labour costs and to cost!!
- The path taken and considerations taken to choose the capture technology
- The consideration process that has been laid out to decide on the next project



My take away's

- Capture technology must be proven at a scale that is acceptable to investors
- Test Centres like TCM, NCC and Shand have a key role.
- A go decision on a new project now could only consider amine based capture
- New capture technologies have to catch up fast!!
- Reducing redundancy in FAOK plant is key to cost reduction



Thank you

Contact me at: john.gale@[ieaghg.org](mailto:john.gale@ieaghg.org)



Website: www.ieaghg.org



LinkedIn: www.linkedin.com/groups/IEAGHG-4841998



Twitter: <https://twitter.com/IEAGHG>



Facebook: www.facebook.com/pages/IEA-Greenhouse-Gas-RD-Programme/112541615461568?ref=hl