



A SUMMARY RECENT GLOBAL CCS DEVELOPMENTS

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IPCC AR5 WG3 Summary for Policy Makers

Energy Supply/CCS (1)



- CO₂ emissions to double or treble from 2010 level of 14.4 Gt/y by 2050
- In last decade main contributors to emissions growth were:
 - Increased energy demand
 - Increased use of coal in global energy mix
- Decarbonizing electricity generation is a key component of **cost-effective** mitigation strategies
 - The share of low-**carbon** electricity supply (including CCS) increases from 30% to more than 80 % by 2050,
 - Fossil fuel power generation without CCS is phased out by 2100.

IPCC AR5 WG3 Summary for Policy Makers



Energy Supply/CCS (2)

- Replacing average efficiency coal fired power plants with modern high efficiency natural gas plants or CHP
- Natural gas without CCS is a bridging technology
- Nuclear is a mature base load technology
 - A lot of risks
- Renewables some technologies reached sufficient maturity for wide scale deployment
 - Grid integration a big issue

IPCC AR5 WG3 Summary for Policy Makers Energy Supply/CCS (3)



- CCS could reduce the lifecycle GHG emissions of fossil fuel plants
 - Components in use but not applied at large scale!
 - No commercial scale CCS power plant!
 - CCS power plants need to be incentivised or become competitive or there are sufficiently high carbon prices!
 - Large scale deployment needs defined long term regulations on liability and financial support!

Define large scale?



Snohvit
0.7Mt/y CO₂



Port Arthur
0.925 Mt/y CO₂



Sleipner
1Mt/y CO₂



In-Salah
1.2 Mt/y CO₂

1 Mt/y CO₂
= 150 MWe



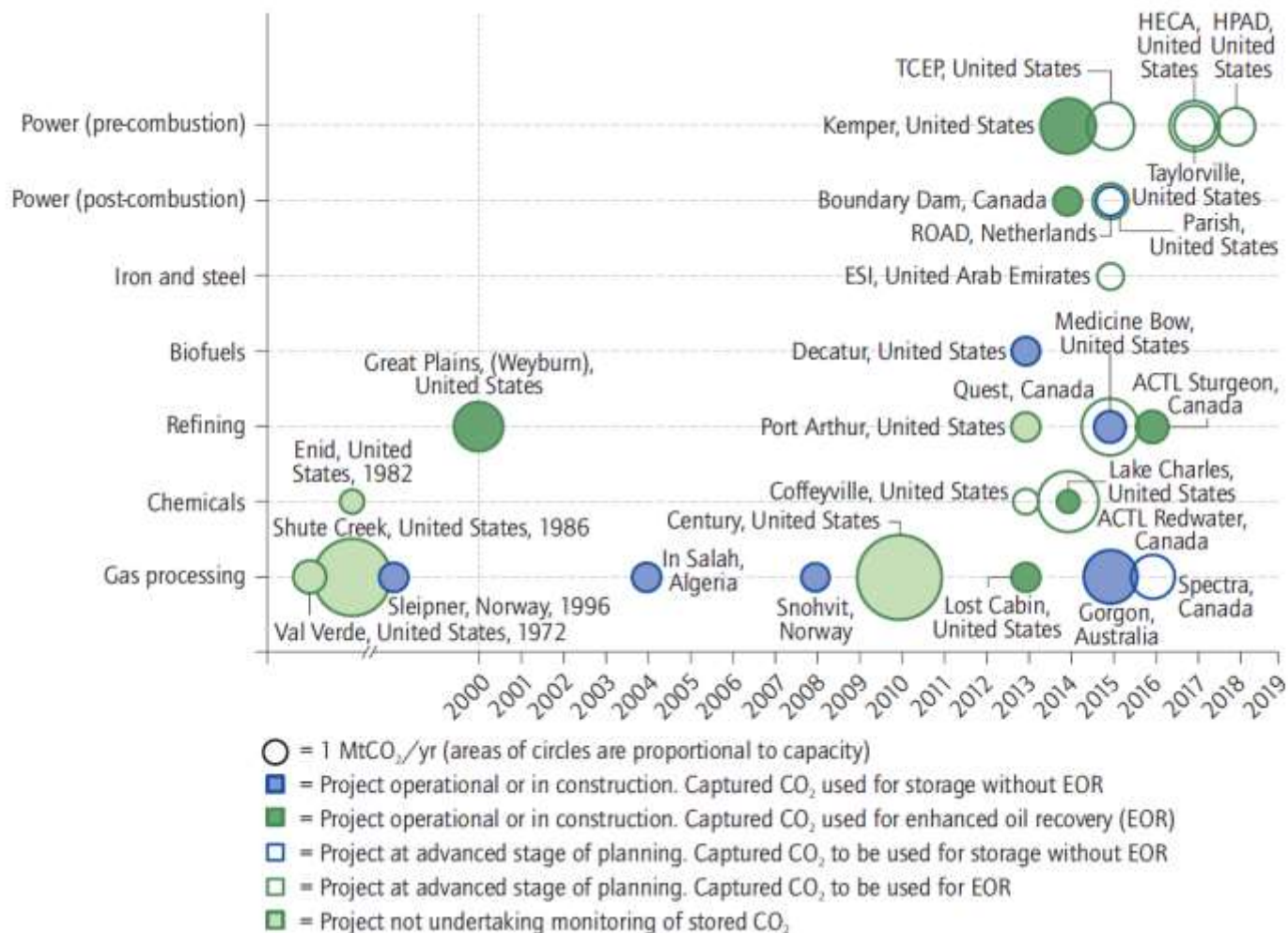
Weyburn
2.5 Mt/y CO₂

Boundary Dam, 110MWe





Progress with integrated projects



Source: Global CCS Institute data

IPCC AR5 Energy Supply/CCS (6)



- CCS barriers;
 - Concerns over operational safety?
 - Long term integrity of CO₂ storage?
 - Transport risks?
- Growing body of knowledge on:
 - how to ensure the integrity of CO₂ wells,
 - on the potential consequences of a pressure build-**up** within a geologic formation (such as induced seismicity),
 - on the potential human health and environmental impacts from CO₂ that migrates out of the primary injection zone

Why is Operational Safety a barrier?



- None of commercial projects have reported any operational issues
- Detailed studies on operational safety have not shown any significant issues
 - All issues handled through existing risk assessment schemes
 - Hazid/HAZAD assessment, Bow tie influence diagrams

Is Long Term Storage Integrity still a barrier?



- Cant demonstrate 1000 year retention in our lifetime !
- Retention mechanisms outlines in IPCC SRCSS in 2005
- EU & US Regulations framed to ensure retention of injected CO₂
- Nearly 20 years of assured storage at Sleipner
- Risk management practises honed
- Modelling tools calibrated against monitoring data
 - Long term storage projections improved

Transport Risks what are they?



- PHMSA provides statistics on pipeline incidents in USA.
 - 46 incidents involving CO₂ pipelines between 1972 and 2012.
 - Natural gas pipeline accidents injured 217 and killed 58 people over the period 1986 – 2001.
 - 550,000 km of NG pipelines vs. 6,500 km CO₂ pipelines in the US).
- No comparable statistics in Europe

IJGGC Created to Build Reference Base for IPCC



- Launched in 2007
- 25 volumes published to date
- 1171 peer reviewed papers published to date
- GHGT conference proceedings published in Energy Procedia
- Wiley – Greenhouse Gases Science and Technology
 - Special issues from Annual CCUS conference in USA
- AAPG, EAGE, SPE etc etc

Impact Factor
3.944

5 year Impact
Factor 5.911

ISSN: 1750-5836



1 BSCSP Basalt	16 MGSC Sugar Creek EOR Phase II	31 SECARB - Stacked Storage Project Cranfield Phase II
2 Carbfix	17 MGSC Tanquary ECBM Phase II	32 SECARB - Mississippi Saline Reservoir Test Phase II
3 CarbonNet	18 Mountaineer	33 South West Hub (Collie South West Hub)
4 CIDA China	19 MRCSP Appalachian Basin (Burger) Phase II	34 Surat Basin CCS Project (Previously Wandoan)
5 CS Energy Callide Oxyfuel Project	20 MRCSP Cincinnati Arch (East Bend) Phase II	35 SWP San Juan Basin Phase II
6 CSEMP	21 MRCSP Michigan Basin Phase II	36 Teapot Dome, Wyoming
7 Fenn/Big Valley	22 Nagaoka Pilot CO2 Storage Project	37 Total Lacq
8 Frio, Texas	23 Otway I (Stage I)	38 West Pearl Queen
9 JCOP Yubari/Ishikari ECBM Project	24 Otway II Project (Stage 2A,B)	39 WESTCARB Arizona Pilot (Cholla)
10 K12B	25 PCOR Lignite	40 WESTCARB Northern California CO ₂ Reduction Project
11 Ketzin	26 PCOR Williston Basin -Phase II (NE Mcgregor Field)	41 WESTCARB Rosetta-Calpine test 1
12 Marshall County	27 PennWest Energy EOR Project	42 WESTCARB Rosetta-Calpine test 2
13 Masdar/ADCO Pilot project	28 Recopol	43 Western Kentucky
14 MGSC Ioudon Field EOR Phase II	29 SECARB - Black Warrior Basin Coal Seam Project	44 Zerogen Project
15 MGSC Mumford Hills EOR Phase II	30 SECARB - Central Appalachian Coal Seam Project	



The role of CCS pilots

- CO₂ injection pilots are currently the key to global implementation of CCS.
 - Building a science/knowledge base
 - Journals/Conference proceedings, AAPG/EGU/SPE etc.,
 - Key to developing public confidence
 - On site exhibitions/public interaction & social science research
 - Contributing to demonstration implementation
 - K12-B allowed the Storage permit for ROAD to be gained from EC
 - Develop expertise for future larger scale implementation
 - Skilled engineers, contractors, equipment suppliers
 - Rank those working in saline formations as most important for the long term



Well Integrity

- Key issues are:
 - New/Existing wells
 - Abandoned wells
- For new/existing wells process of well completion is key to reducing leakage
- Abandoned wells in area of influence of the plume are main issue
 - May not know how these have been abandoned?
 - May need to renter and recomplete wells

Pressure Build-Up



- **Infamous “Zoback” paper raised the profile**
- Two studies one by IEAGHG and the other by US NAS suggested:
 - No evidence of induced seismicity at existing CO₂ injection sites
 - But injection volumes small
 - Pressure build up needs to be factored into project design
 - Gorgon, Western Australia
 - A lot of modelling work suggests pressure relief can be a successful technique.

Controlled Release Projects



- CO2FieldLab (Norway)
- ZERT (USA)
- QICS (UK)
- PISCO2 (Spain)
- ASGARD (UK)
- CIPRES (France)
- **EPRI's (USA)**
- Ginninderra (Australia)
- Petrobras (Brazil)
- Vrogum (Denmark)



IPCC AR5 WG3 Summary for Policy Makers Energy Supply/CCS



- Bio-CCS offers prospect of large scale energy supply with negative emissions
- Risks:
 - Large scale biomass supply (agree – has GHG implications need to look at full life cycle)
 - CCS risks – **Don't** agree as indicated for CCS.
- IEA GHG believes barriers are:
 - No allowance for negative emissions in EU ETS
 - Gasification technology unproven at scale

Summary

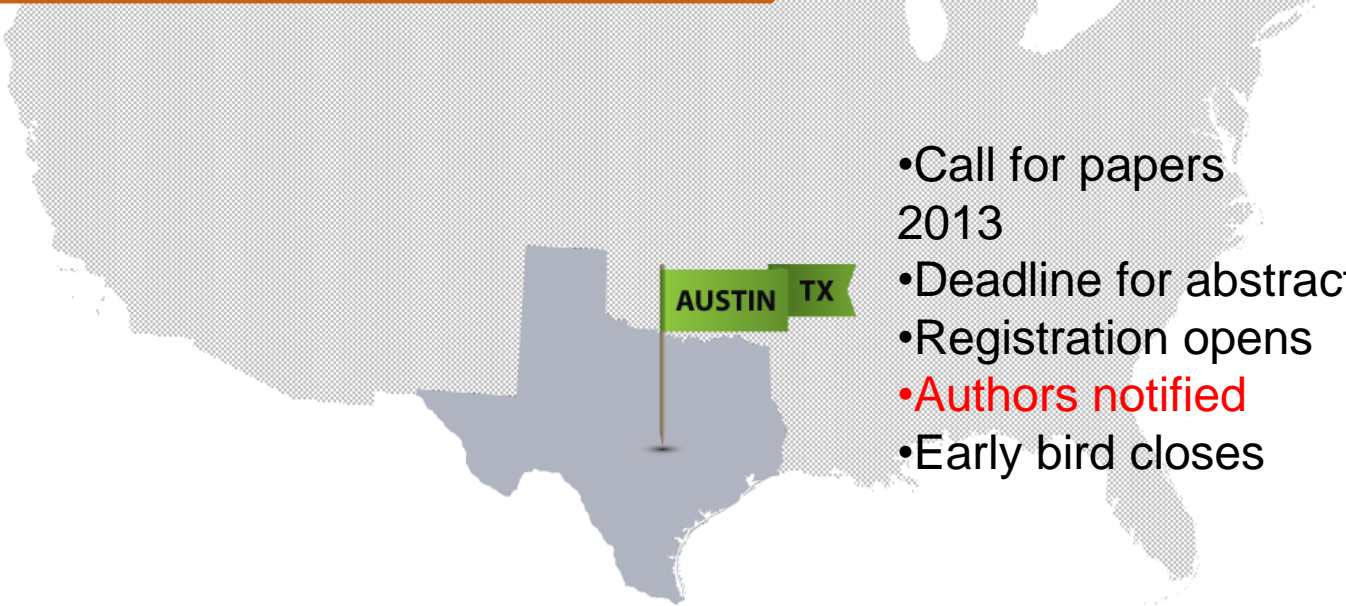


- IPCC WG3 Report gives positive messages on need for CCS.
- Also has a negative stance on status of CCS
 - Noted that report long time in drafting -2 years
 - Process very political
- Need to be more vocal about our successes not keep identifying more gaps
- Pilots are playing a key role and will do for many years to come+



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October 5 - 9
TWO THOUSAND FOURTEEN
AUSTIN, TX – USA

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- A grey silhouette map of the United States with a green pin in the state of Texas. The pin has a green flag with the text 'AUSTIN TX' on it.
- Call for papers 2013 27th September
 - Deadline for abstracts 10th January 2014
 - Registration opens 7th March 2014
 - Authors notified 2nd May 2014**
 - Early bird closes 13th June 2014