



# A SUMMARY RECENT GLOBAL CCS DEVELOPMENTS

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# IPCC AR5 WG3 Summary for Policy Makers Energy Supply/CCS (1)



- CO<sub>2</sub> 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 CO<sub>2</sub>**



**Port Arthur**  
**0.925 Mt/y CO<sub>2</sub>**



**Sleipner**  
**1Mt/y CO<sub>2</sub>**



**In-Salah**  
**1.2 Mt/y CO<sub>2</sub>**

**1 Mt/y CO<sub>2</sub>**  
**= 150 MWe**



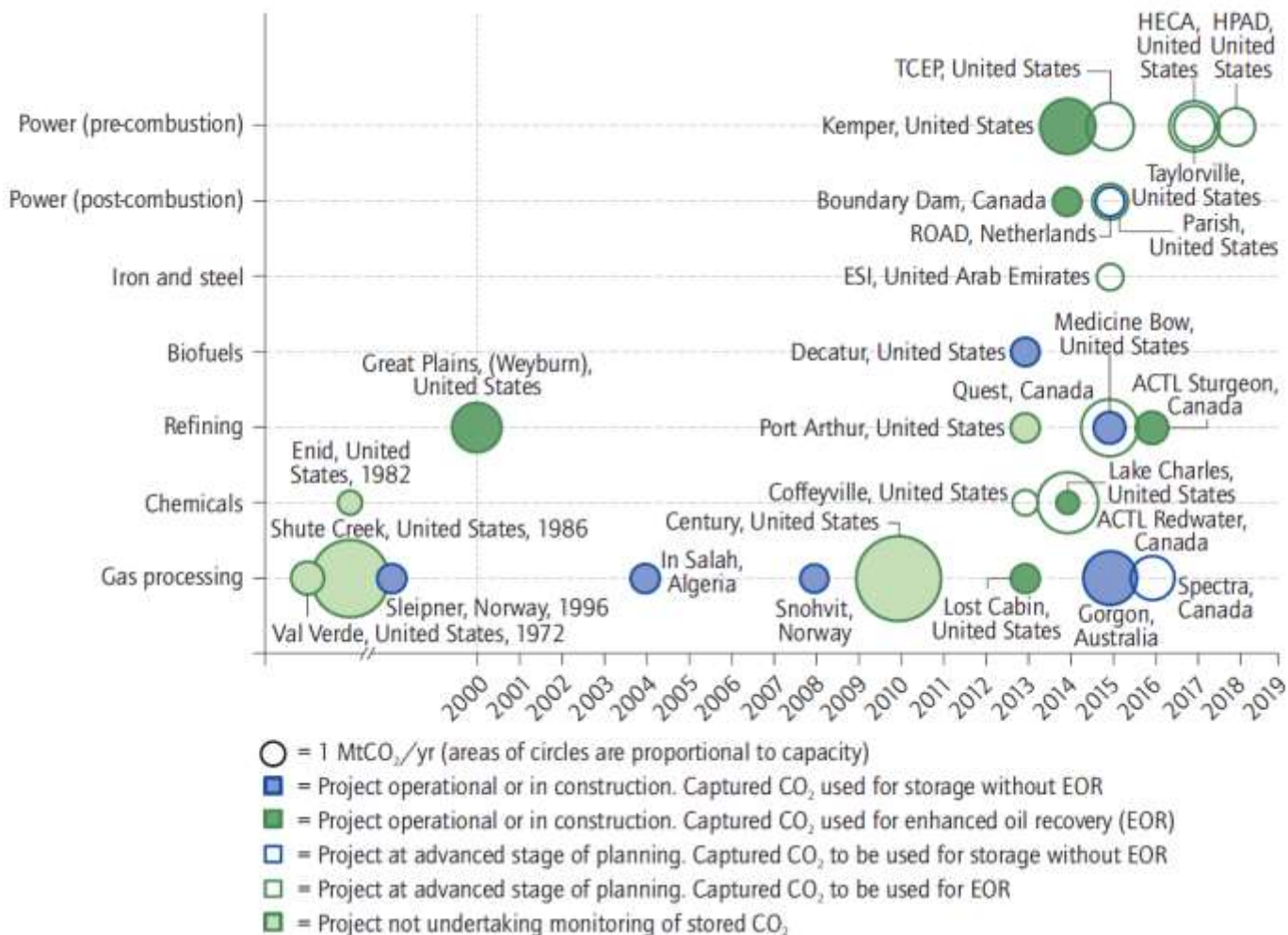
**Weyburn**  
**2.5 Mt/y CO<sub>2</sub>**

# 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 CO<sub>2</sub> storage?
  - Transport risks?
- Growing body of knowledge on:
  - how to ensure the integrity of CO<sub>2</sub> 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 CO<sub>2</sub> 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 CO<sub>2</sub>
- 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 CO<sub>2</sub> 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 CO<sub>2</sub> 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 <sub>2</sub> 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

- CO<sub>2</sub> 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 CO<sub>2</sub> 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

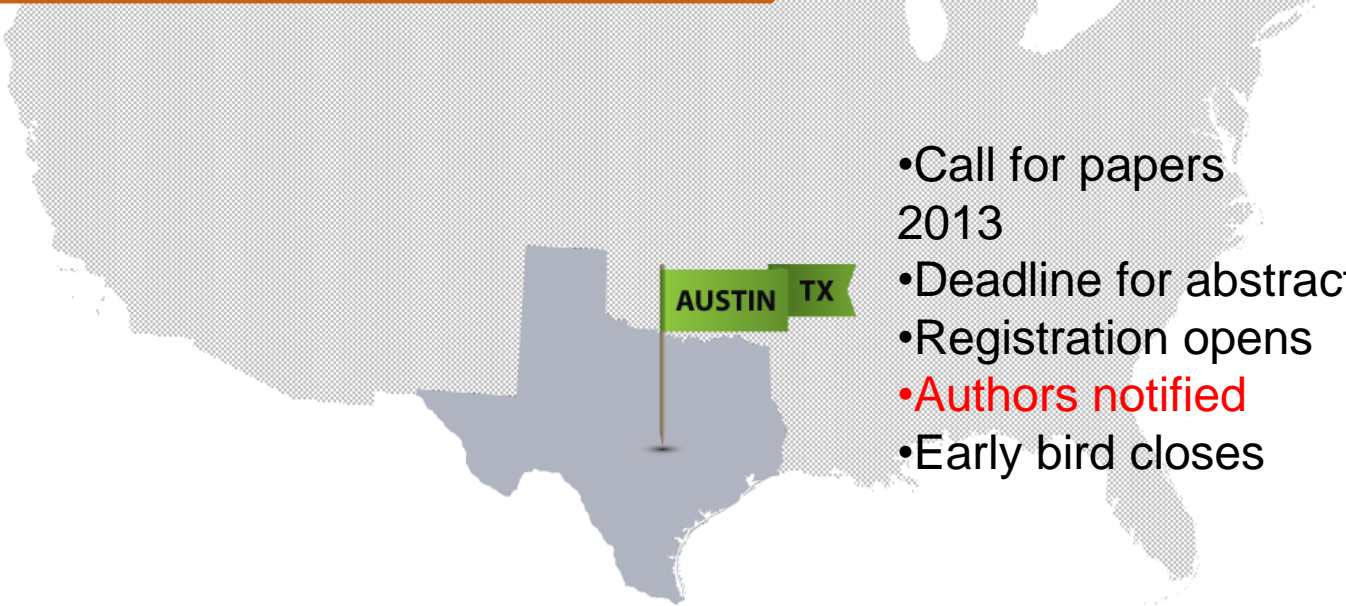


- IPCC WG3 Report gives positive messages on need for CCS.
- Also has a negative stance on status of CCS
  - Noted that report long time in drafting -2 years
  - Process very political
- Need to be more vocal about our successes not keep identifying more gaps
- Pilots are playing a key role and will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



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- Call for papers 2013 27<sup>th</sup> September
  - Deadline for abstracts 10<sup>th</sup> January 2014
  - Registration opens 7<sup>th</sup> March 2014
  - **Authors notified 2<sup>nd</sup> May 2014**
  - Early bird closes 13<sup>th</sup> June 2014