IEA Greenhouse Gas R&D Programme

# Global Status of CCS
# Do we have a full portfolio?


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**IENE Seminar**

**The Prospects for $CO_2$ Capture and Storage in Greece»**

**December 17, 2009, Kozani, Greece**

# Introduction

- Briefly introduce IEA GHG
- What we need to demonstrate CCS
- Discuss what we have learnt to date
- Look at the forward agenda for CCS.

# IEA Greenhouse Gas R&D Programme

- A collaborative research programme founded in 1991
- Aim: *Provide members with definitive information on the role that technology can play in reducing greenhouse gas emissions.*
- Producing information that is:
  - Objective, trustworthy, independent
  - Policy relevant but NOT policy prescriptive
  - Reviewed by external Expert Reviewers
  - Subject to review of policy implications by Members
- Activities: Studies (>150); R&D networks :- Wells, Risk, Monitoring, Oxy, Capture, Biofixation; Communications (GHGT9, IJGGC, etc); facilitating and focussing R&D and demonstration activities
- Funding approx 2 million €/year (2.6 million $/year).

# Contracting Parties and Sponsors

# Portfolio Approach Required

- Need to ensure all technical combinations are tested and assured
  - All fossil fuels tested in combinations
  - All capture technology options tested and components assured
  - Transmission options tested
  - Likely range of geological storage options tested and geological range assessed
- How can this best be achieved?

# What Do We Need To Demonstrate?

- Power Plants
  - 3 main capture technologies
    - Post Combustion
    - Precombustion IGCC
    - Oxyfuel
  - Transport
    - Pipeline
    - Sea borne – regional & Martime?
  - Storage
    - Cover all the options?
- Industry
  - Capture at cement plant
  - Capture at iron & steel
  - Capture at Ammonia plant
  - Capture at Refineries
  - Capture at smelting plant
  - Capture at oil and gas processing plant

IEA Greenhouse Gas R&D Programme

# Capture & Storage Technical Status

**Snohvit capturing and injecting 0.7Mt/y $CO_2$ since 1996**

**Rangeley injecting 3 Mt/y $CO_2$ since 1996**

**Sleipner capturing and injecting 1Mt/y $CO_2$ since 1996**

**Weybur capturing injecting 1 $CO_2$ since**

Total Anthropogenic $CO_2$ captured and injected currently 7Mt/y

**In-Salah capturing and injecting 1Mt/y $CO_2$ since 2004**

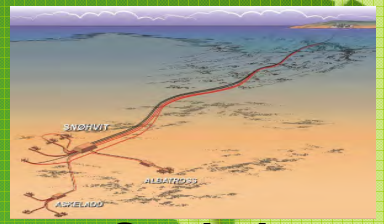
# Capture and Transport Technical Status

ICO2N

**Pipeline network to capture and supply 1.2Mt/y CO2 by 2010**


CO flooding in the Permian Basin demonstrating COsources (yellow), flooded oil fields (green) and associated transmission lines.

**Permian Basin, 3000km pi**




**Snohvit 160km Sub sea pipeline**


**Weyburn 300km transboundary pipeline**

**Long distance transport of $CO_2$ by pipeline is established technology**

# What have we learnt to date - projects?

- Review current operational large-scale CCS projects
  - Assess learning from projects
  - Identify gaps in the global CCS project portfolio
- Focus on projects relevant to full-commercial scale operation
  - Includes:
    - Large-scale pilot
    - Demonstration
    - Commercial
  - Excludes
    - Small and medium pilot
    - Lab scale
  - Define criteria – Identify projects – Collect information - Analyse

# Criteria for large-scale operational projects

- Indicative criteria defined for ‘large-scale operational projects’
- Was, or had been, operational by the end of 2008, and either:-
  - Captured over 10,000 $tCO_2$ per year from a flue gas
  - Injected over 10,000 $tCO_2$ per year with the purpose of geological storage with monitoring
  - Captured over 100,000 $tCO_2$ per year from any source
  - Coal-bed storage of over 10,000 $tCO_2$ per year
- *Commercial CO2-EOR was excluded unless there was a monitoring programme to provide learning*
- *Did not need to be fully integrated*
- Added term ‘*large-scale operational*’ to IEA GHG Projects Database

# Projects identified

| | |
|---|---|
| Bellingham Cogeneration Facility | IFFCO CO2 Recovery Plant – Aonla |
| CASTOR Project | Prosint Methanol Plant |
| Great Plains Synfuel Plant | Rangely CO2 Project |
| IMC Global Soda Plant | Schwarze Pumpe |
| In Salah | SECARB - Cranfield II |
| K12-B | Shady Point Power Plant |
| Ketzin Project | Sleipner |
| MRCSP - Michigan Basin | Snohvit LNG Project |
| Nagaoka | SRCSP - Aneth EOR-Paradox Basin |
| Otway Basin Project | SRCSP - San Juan Basin |
| Pembina Cardium Project | Sumitomo Chemicals Plant |
| Petronas Fertilizer Plant | Warrior Run Power Plant |
| IFFCO CO2 Recovery Plant - Phulpur | Weyburn |
| Chemical Co. “A” CO2 Recovery Plant | Zama EOR Project |

- Capture over 100kt$CO_2$
- Injection over 10kt$CO_2$ for storage
- Monitored EOR over 10kt$CO_2$
- Capture over 10kt$CO_2$ from flue gas
- Coal bed storage over 10kt$CO_2$

# Project Locations

- Capture over 100kt$CO_2$
- Injection over 10kt$CO_2$ for storage
- Monitored EOR over 10kt$CO_2$
- Capture over 10kt$CO_2$ from flue gas
- Coal bed storage over 10kt$CO_2$

# Extent of coverage - Capture

- 13 plants capturing $CO_2$ from combustion processes
  - 11 post-combustion
  - 1 pre-combustion
  - 1 oxyfuel
- 9 projects source $CO_2$ from industrial processing (Natural gas separation, ammonia, LNG, hydrogen production)
- Multiple fuels represented
  - Hard coal
  - Lignite
  - Natural Gas
  - Industrial processes
- Over 10Mt of $CO_2$ captured per year

# Extent of coverage - Transport

- Pipeline
  - Single sink source pipelines
  - Multiple source-multiple sink pipeline networks
- Truck
- Cross-border transport
- Transport over 860km

# Extent of coverage vs ZEP project matrix

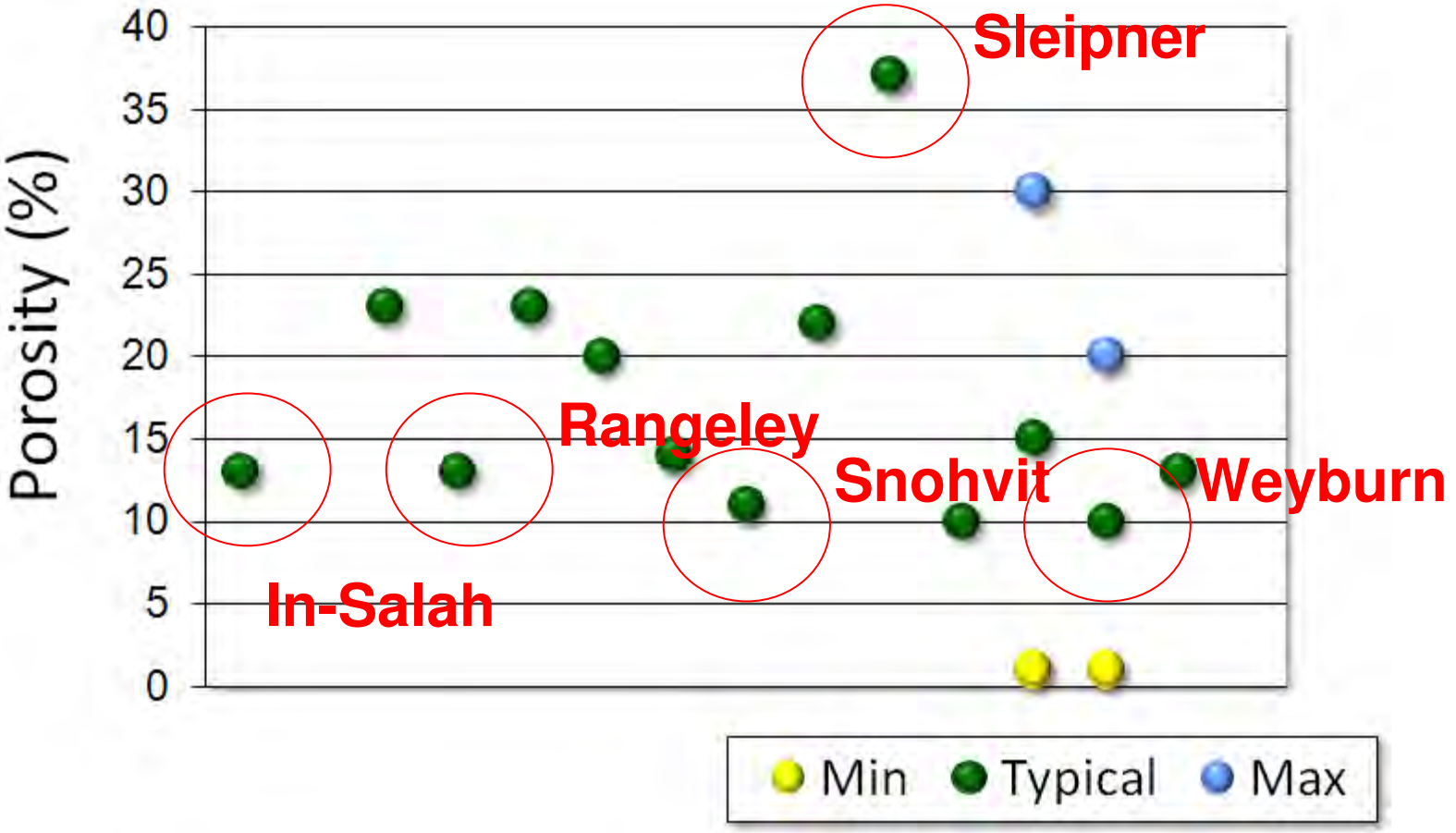
| | | | | |
|---|---|---|---|---|
| Archetype 1 | • Lignite/co-firing with Biomass | • Pre-combustion, variant A | • Cross-border pipeline | • Offshore depleted oil & gas field |
| Archetype 2 | • Gas | • Post-combustion, variant A | • Pipeline | • Onshore structural deep saline aquifer |
| Archetype 3 | • Hard Coal | • Oxy-fuel, variant A | • Ship | • Offshore open deep saline aquifer |
| Archetype 4 | • Hard Coal | • Post-combustion, variant A | • Pipeline | • Onshore depleted oil & gas field |
| Archetype 5 | • Lignite | • Oxy-fuel, variant B | • Pipeline | • Onshore structural deep saline aquifer |
| Archetype 6 | • Hard Coal | • Pre-combustion, variant B | • Pipeline | • Offshore depleted oil & gas field |
| Archetype 7 | • Hard Coal | • Post-combustion, variant B | • Pipeline | • Onshore open deep saline aquifer |

Demonstrated in operational large projects

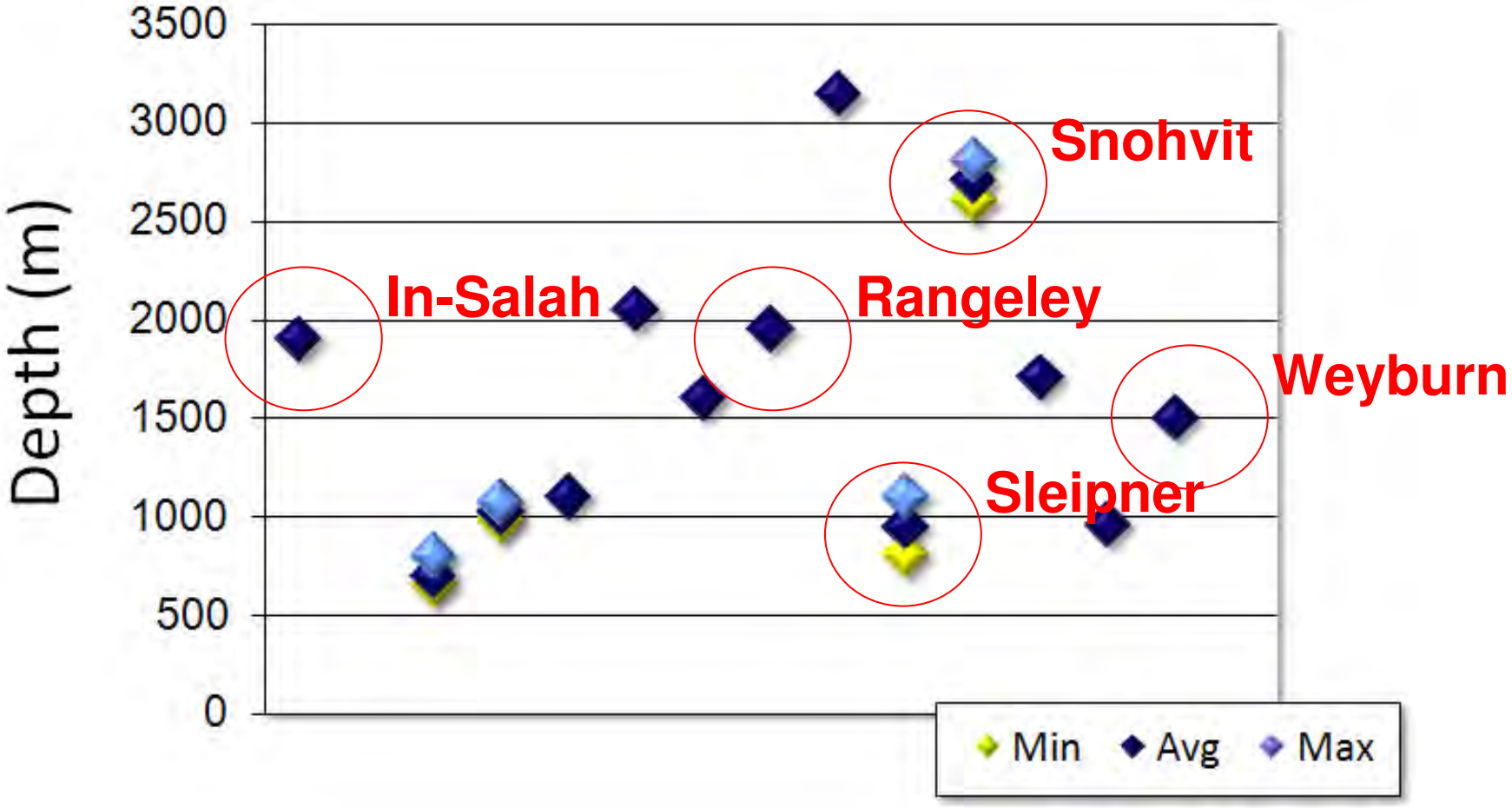
Not demonstrated in operational large projects

Project matrix courtesy of EU Technology Platform for Zero Emission Fossil Fuel Power Plants - ZEP (2008)

# Porosity Range of large Injection Projects



# Reservoir Depths



# Extent of coverage - storage

- Data from 13 $CO_2$ injection projects
- $CO_2$ has been injected into:
  - Unconsolidated sand bodies offshore (Sleipner)
    - Porosity 37%
  - Both tight sandstone and carbonate reservoirs on shore (In-Salah & Weyburn)
    - Porosities down to 10%
  - Depths ranging from 800 to >3000m

# Extent of coverage – injection wells

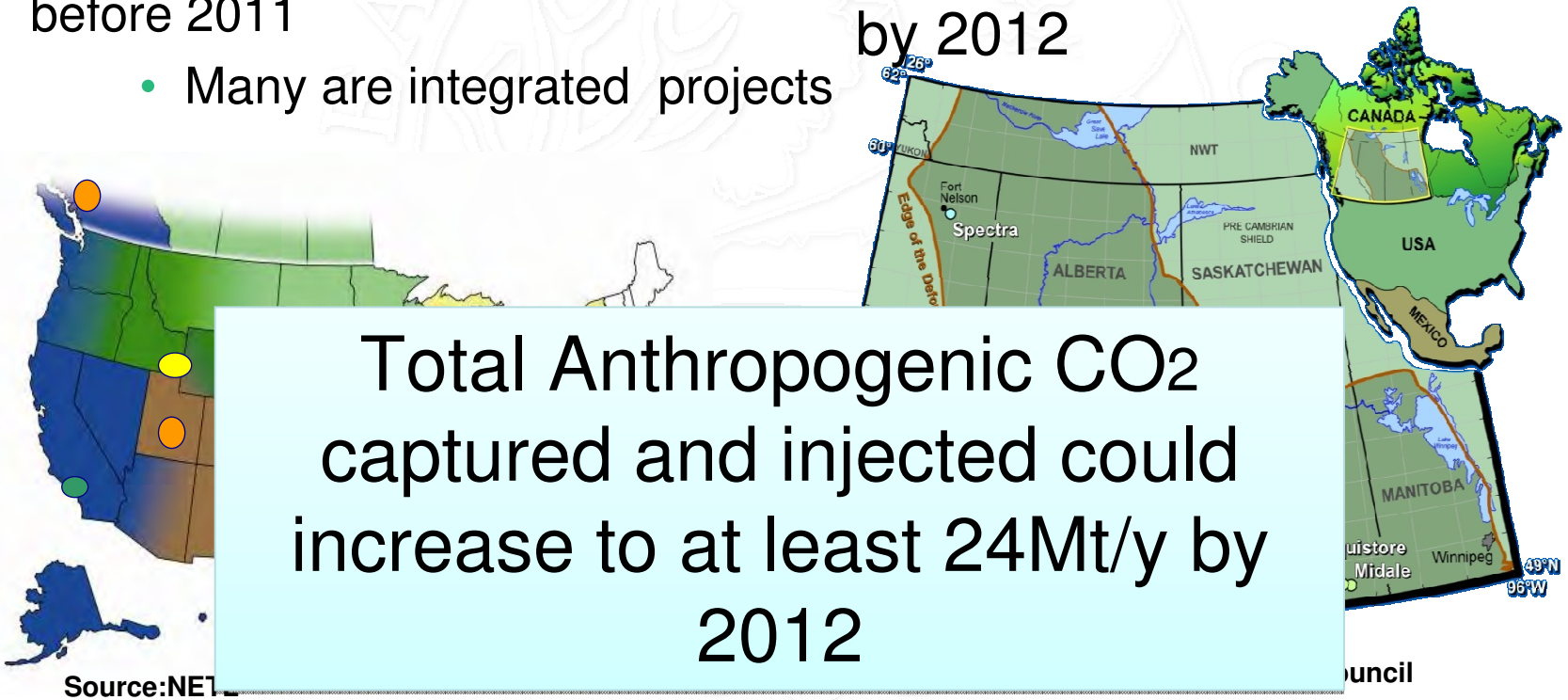
- Some injection problems identified
  - No insurmountable problems
- Injection wells
  - Single well - Sleipner
  - Multiple distributed wells – Weyburn
  - Both new and existing wells used

# Summary

- Projects underway to date have demonstrated:
  - Range of capture options at 1 MT/y scale in power sector and some industry sectors.
  - Pipeline transport of $CO_2$
  - That injection into a wide range of geological formations is feasible
- This data set is going to expand

# New Commercial Scale Developments

- US Regional Carbon Sequestration Programme
- 9 planned 1Mt/year projects to start before 2011
  - Many are integrated projects
- Planned Aquifer projects in Canada could add 6-8Mt/y $CO_2$ captured and stored by 2012

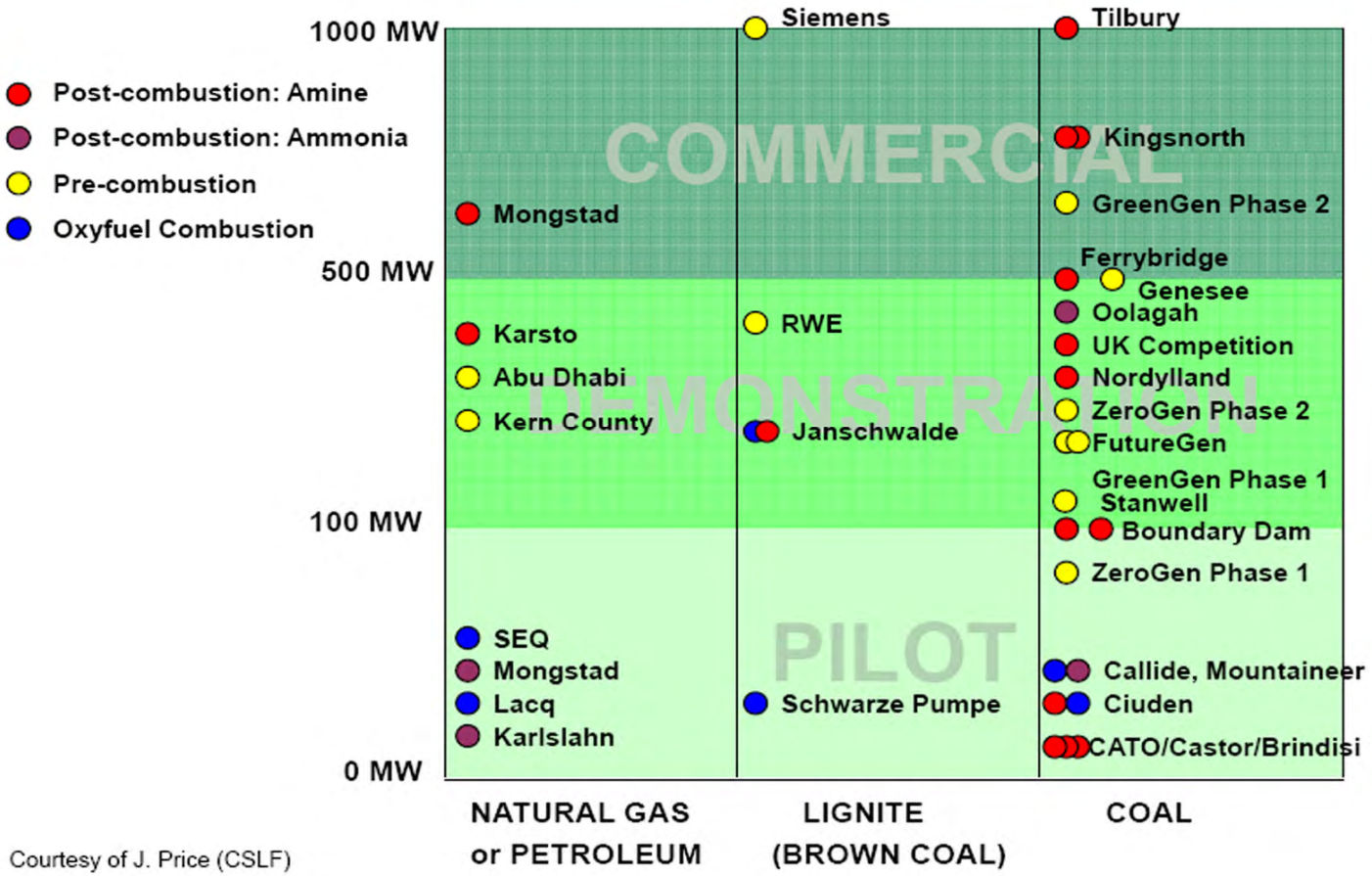



Total Anthropogenic $CO_2$ captured and injected could increase to at least 24Mt/y by 2012

Source:NET… …uncil

# Planned and Proposed Integrated Demos.

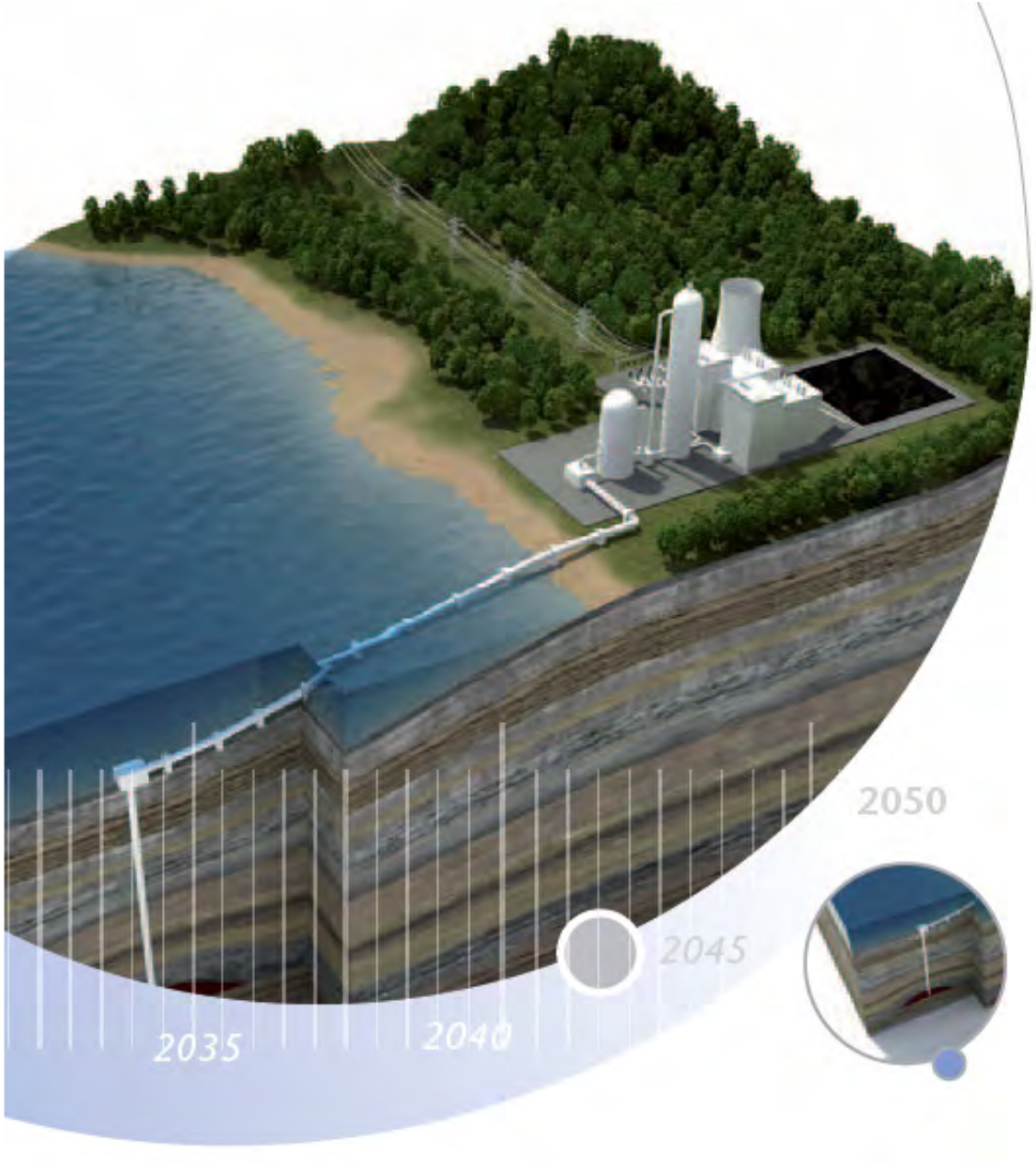
## (illustrative as of June 2008)




Courtesy of J. Price (CSLF)

# Integrated Demonstration Plant Initiatives

- European Commission in 2007 set out a plan for 10-12 demonstration plants
  - Draft Storage Directive
  - Programme to monitor demonstrations
- IEA Recommendations to G8
  - Need for 20 demonstration plants by 2020
  - Endorsed by G8 at Hokkaido Summit in Spring 2008
- GCCSI established in 2009 to progress uptake of 20 demonstration projects globally by 2020




# IEA CCS Roadmap

NAME

Technology Roadmap

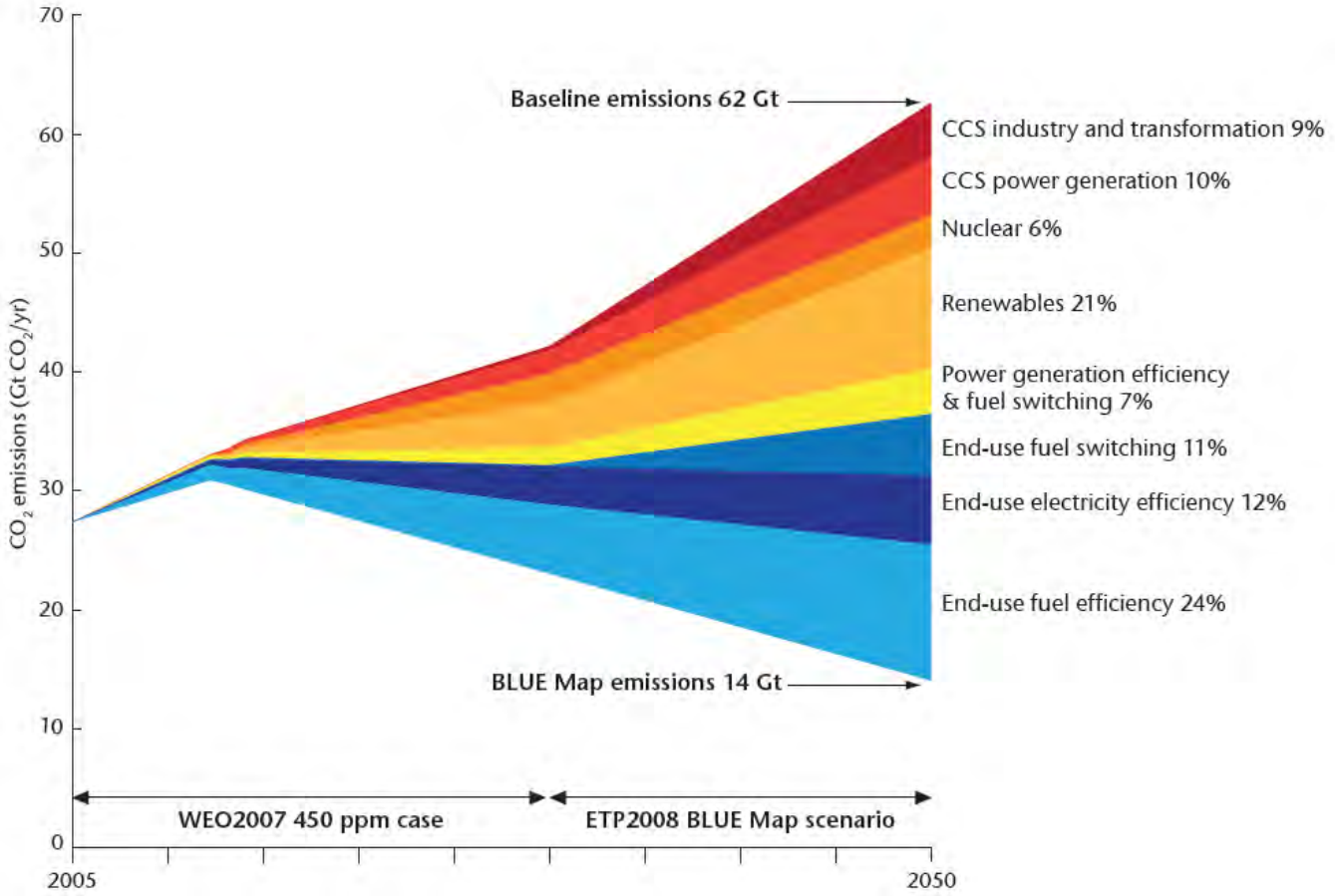
Carbon capture and storage

International Energy Agency

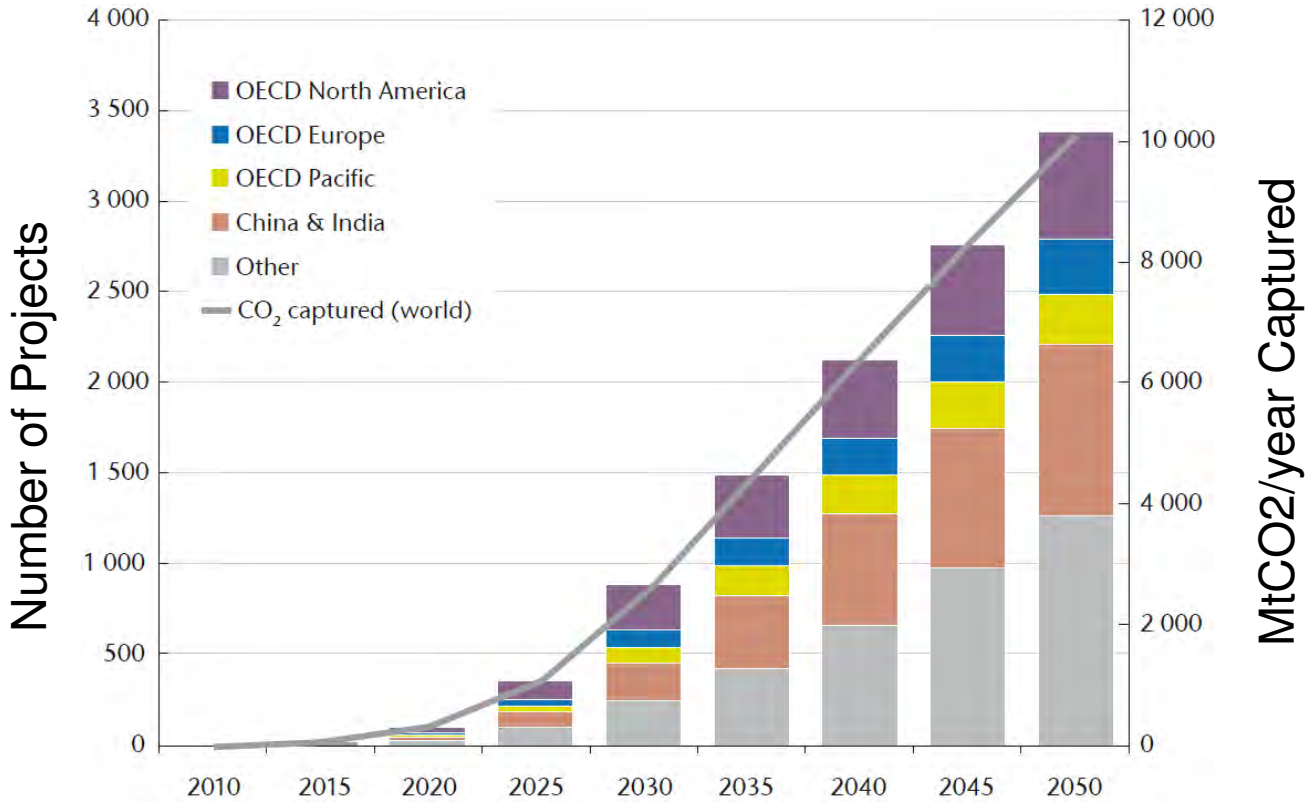
# The rationale for CCS

- Without new policies, global emissions increase by 130% by 2050, leading to a 4-7°C temperature rise
- CCS provides one-fifth of the needed $CO_2$ reductions in 2050
- Without CCS, cost of stabilization rises by 70%
- CCS is the only low-carbon solution for gas/coal, cement, and iron & steel sectors

# The ETP BLUE Map Scenario

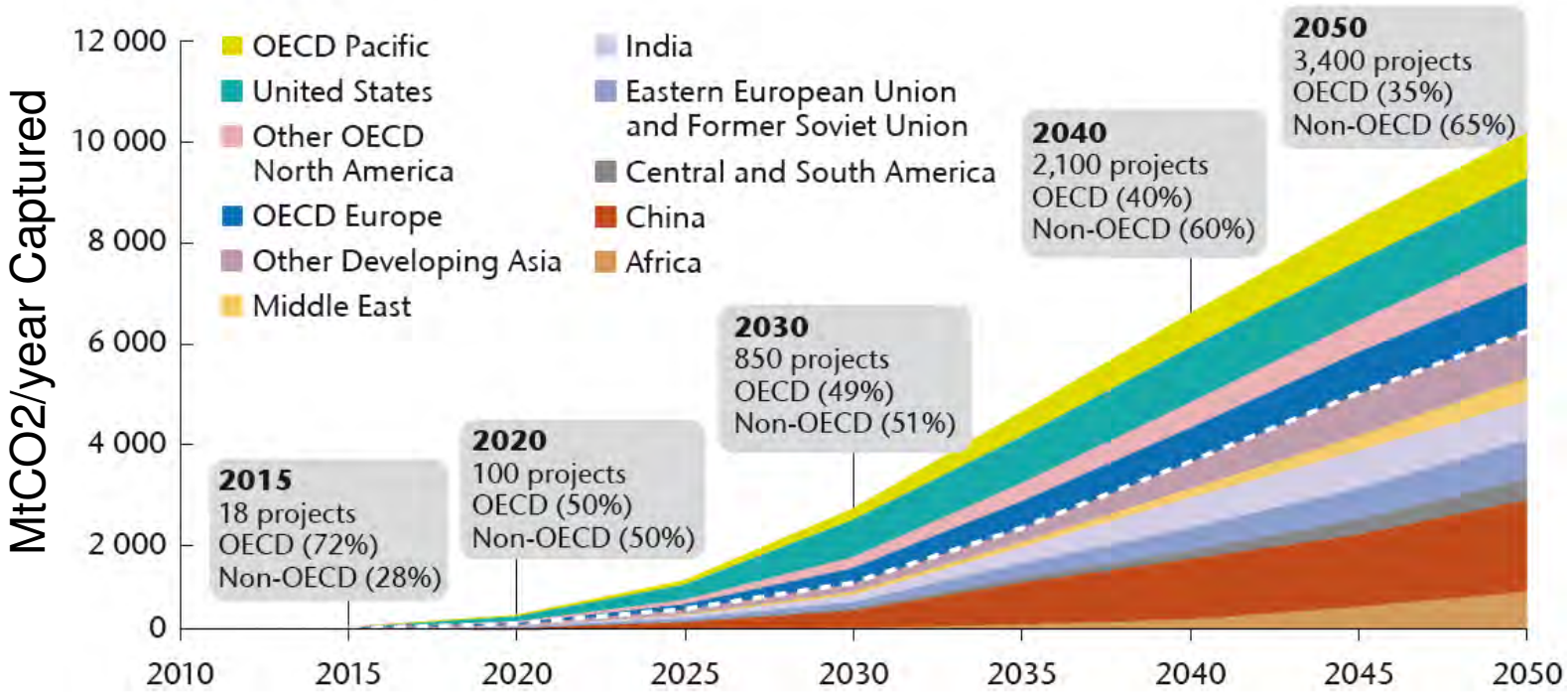


# CCS deployment in the BLUE Map Scenario




There is an ambitious growth path for CCS from 2010 to 2050

# An ambitious growth pathway




OECD regions must lead in demonstrating CCS, but the technology must quickly spread to the rest of the world

# Thank You!

Happy to take any questions!

For more information on CCS attend:

GHGT-10
19th-23rd September 2010,
Amsterdam, The Netherlands
www.ghgt.info