

# Large Scale CCS Demonstration Projects in the U.S.

World Energy Council,  
Cleaner Fossil Fuels  
Systems Committee

Forum on Carbon  
Capture and Storage

Abu Dhabi

United Arab Emirates

21 January 2010



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# CCS Size Translation

What is a Gigaton (Gt) of CO<sub>2</sub>?

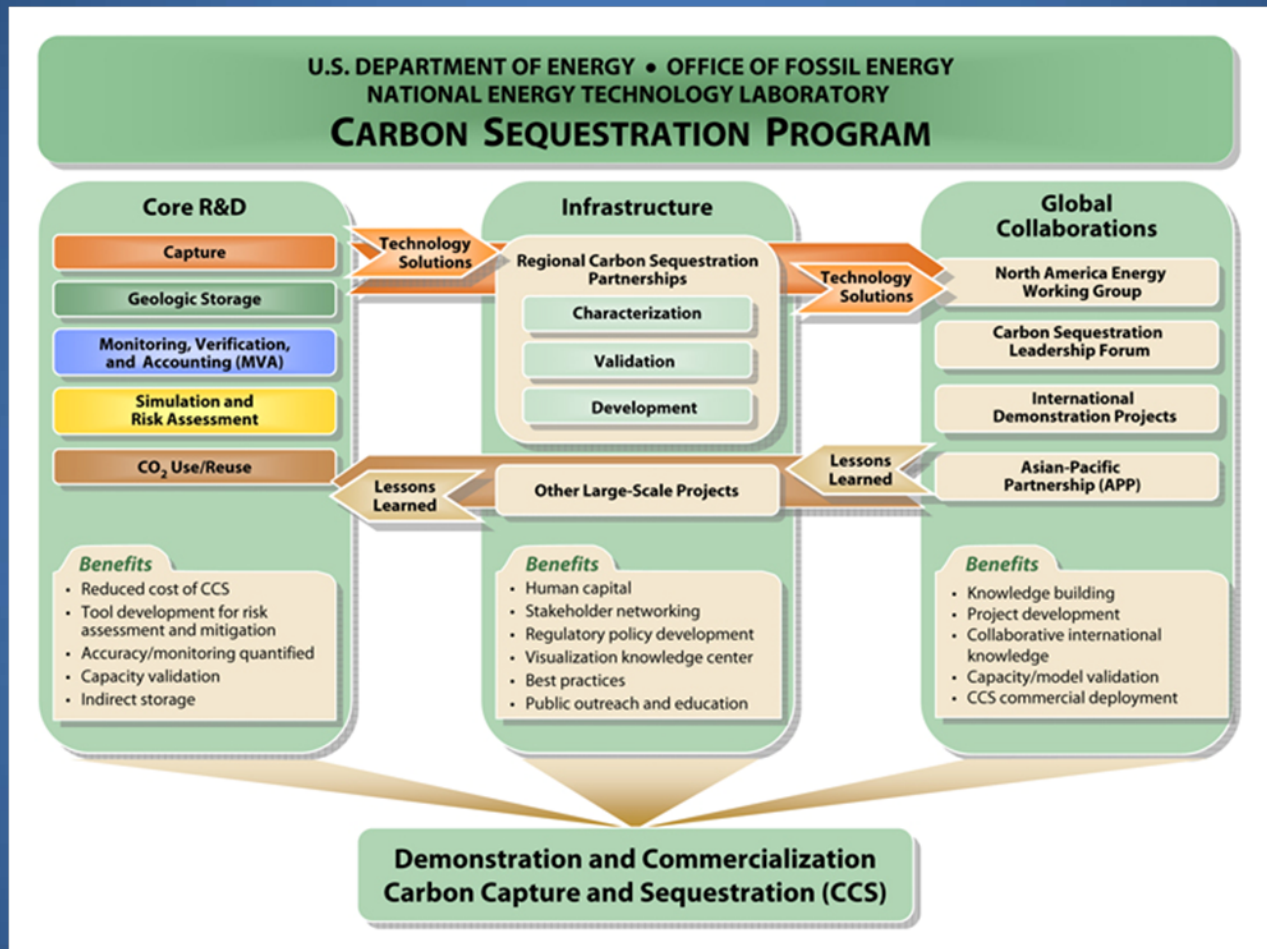
- 1 billion tonnes
- ~ 20 TCF natural gas (1 Mt ~ 20 BCF)
  - U.S. natural gas production ~ 22.3 TCF/yr
  - World natural gas production ~ 100 TCF/yr
- ~ 20-25 million barrels supercritical CO<sub>2</sub>/day
- 1,000 MW coal power plant ~ 8 Mt/yr CO<sub>2</sub>
- Over 30 yrs storage needed for ~ 1.65 billion barrels

# Large-Scale CCS Projects

- Large enough to demonstrate technical and operational viability of commercial systems
- Location - clearly identified
- Integration of capture, transport and storage
- Full-scale operation between 2015-20
- Strategies to engage the public
- Funding commitments demonstrate public and private sector support

*“Large-scale” criteria varies worldwide but in the U.S. > 1 Mt CO<sub>2</sub> captured or stored*

# U.S. Carbon Sequestration Program



*Emphasis on CCS demonstration & deployment*

~ \$631 million Federal investment to date with 80 active R&D projects

Source: NETL/DOE

# Regional Carbon Sequestration Partnerships

- Engage regional, state, local govts
- Determine regional sequestration benefits
- Baseline region for sources and sinks
- Establish MVA protocols
- Address regulatory, environmental, and outreach issues
- Validate technology and infrastructure



*Infrastructure development and geologic storage demonstration for large-scale CCS deployment*

# Partnership Phases

Phase I: Characterization  
(2003-2005)

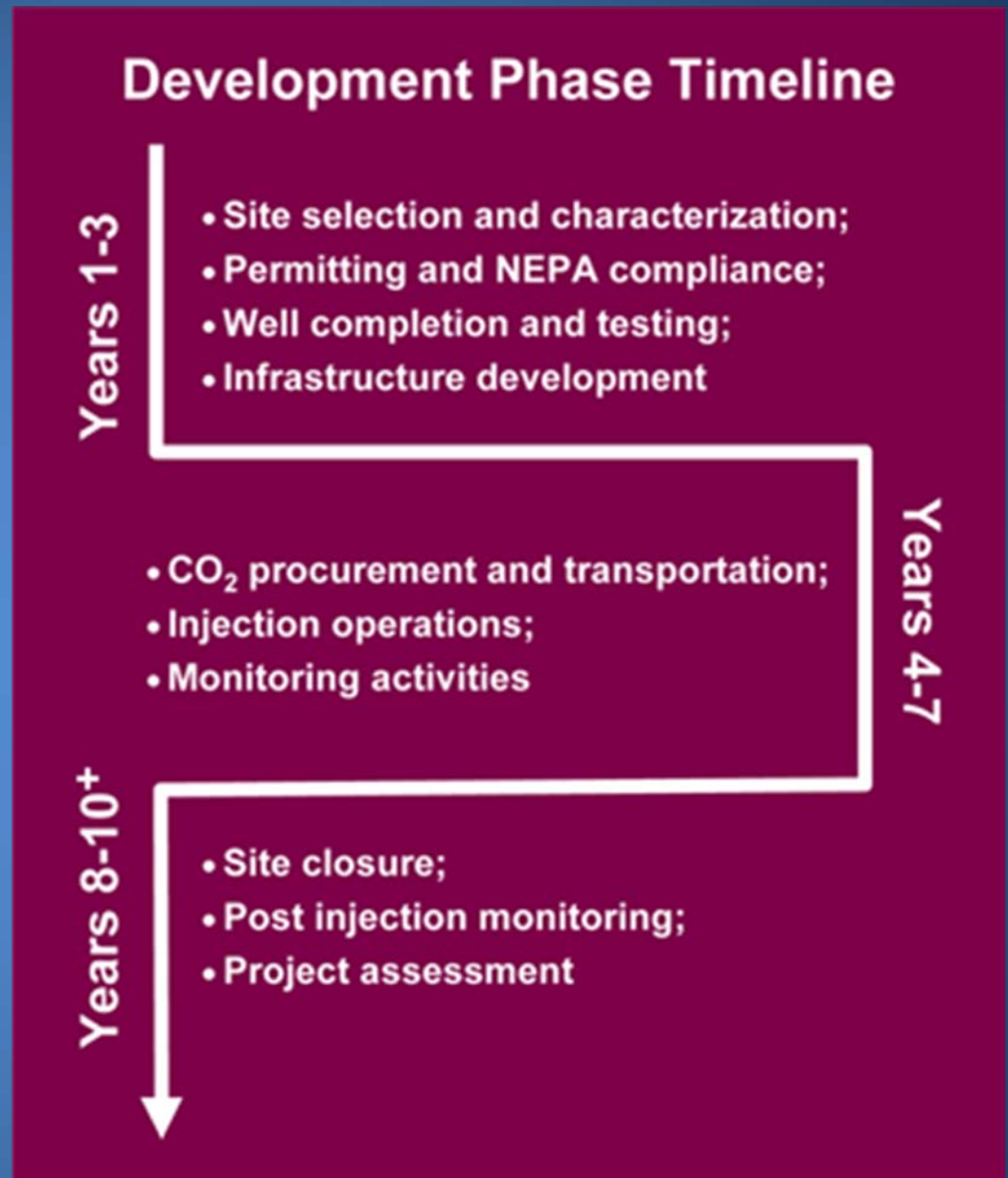
\$16 m DOE; \$5 m CS

Phase II: Validation  
(2005-2010)

\$120 m DOE; \$43 m CS

Phase III: Development  
(2008-2017)

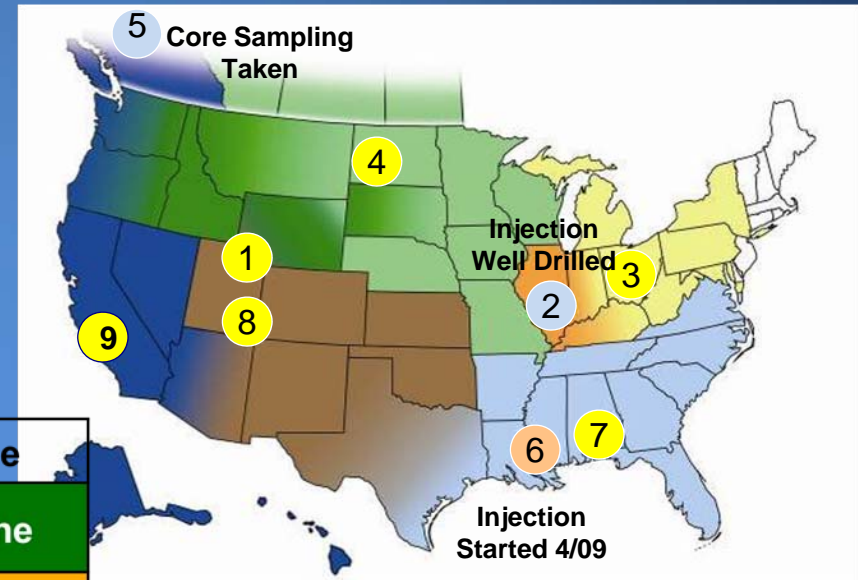
~\$500 m DOE; >\$200m CS



**Best Practice Manuals for Phase II & III**

# Large-Scale Geologic Field Tests

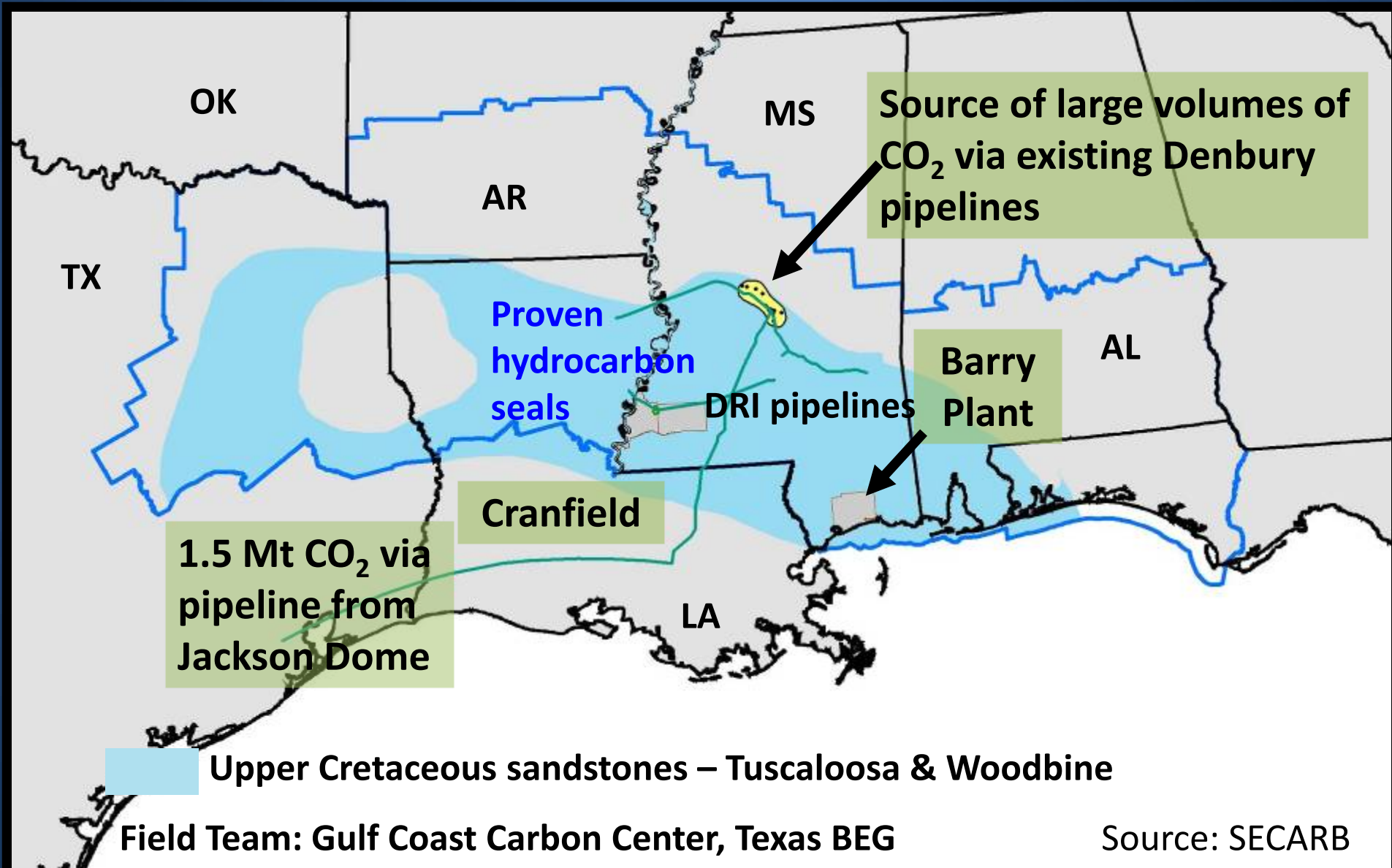
- > 1 million tons of CO<sub>2</sub>
- Demonstrate CO<sub>2</sub> storage potential
- Address practical and operational issues (i.e. well design and reservoir behavior)



	Partnership	Geologic Province	Type
1	Big Sky	Triassic Nugget Sandstone / Moxa Arch	Saline
2	MGSC	Deep Mt. Simon Sandstone	Saline
3	MRCSP	Shallow Mt. Simon Sandstone	Saline
4	PCOR	Williston Basin Carbonates	Oil Bearing
5		Devonian Age Carbonate Rock	Saline
6	SECARB	Lower Tuscaloosa Formation Massive Sand Unit	Saline
7			
8	SWP	Regional Jurassic & Older Formations	Saline
9	WESTCARB	Central Valley	Saline

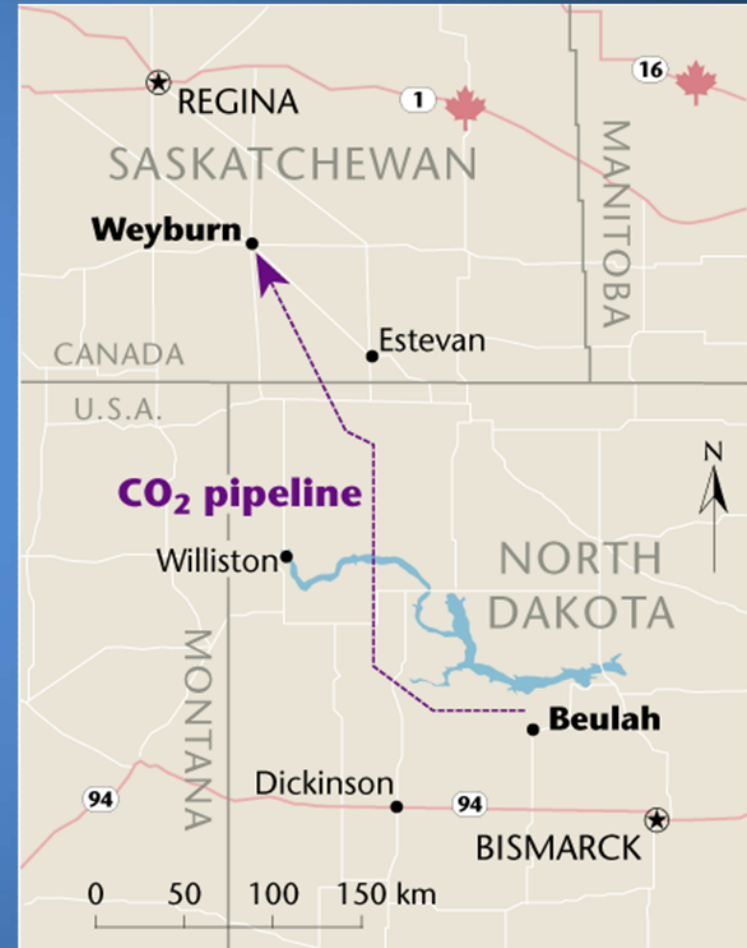
- 2009 Injection Scheduled
- 2010/2011 Injection Scheduled
- 2011/2012 Injection Scheduled

# SECARB Cranfield Project



# Weyburn-Midale CCS Project

- Launched in 2000
- Capture at Basin Electric's Dakota Gasification
- Transport via 320 km pipeline
- Injection by EnCana at Weyburn oil field for EOR and carbon storage
- ~ 10 million tonnes CO<sub>2</sub> stored
- International CO<sub>2</sub> monitoring program



*Largest CCS project in the world*

Source: Canadian Geographic

# Antelope Valley CCS Project

- Basin Electric, Doosan Babcock & HTC Pureenergy
- Retrofit 450 MW unit with post-combustion capture
- 90 percent CO<sub>2</sub> removal
- 3,000 tons/day; 1 million tons/year
- Pipeline-quality CO<sub>2</sub> for EOR/storage
- DOE CCPI support (\$100 m)
- FEED study underway



Basin Electric's Antelope Valley Station, a coal-fired power plant near Beulah, North Dakota

***Recent Board approval for FEED; commercial decision not yet made***

# Hydrogen Energy California (HECA)



Proposed IGCC power plant in Kern County, California, a joint venture between BP and Rio Tinto

***May be the first power plant with CCS in the U.S.***

- IGCC with feedstock blend of coal/pet coke
- Convert to H<sub>2</sub> and CO<sub>2</sub>
- H<sub>2</sub> for power gen
- CO<sub>2</sub> separation and capture with methanol-based Rectisol
- > 2 Mt CO<sub>2</sub>/yr
- CO<sub>2</sub> for EOR / storage
- DOE CCPI support (\$308 million)

# TXE Carbon Management & Gasification Project

- Petcoke feedstock to syngas
- Methanol, ammonia and H<sub>2</sub> production
- CO<sub>2</sub> capture and transport via pipeline for EOR/storage
- Advanced development – FEED complete, \$230 m + invested
- DOE loan guarantees



The TXE Industrial Gasification Facility planned in Beaumont, TX and owned by TX Energy, subsidiary of Eastman Chemical Company

***CCS commercial gap and risk too high;  
project recently cancelled***

Source: Coal Gasification News

# DOE's Global CCS Involvement

Location	Operations	U.S. Invol.	Reservoir	Operator /Lead	Int'l Recognition
North America, Canada Saskatchewan Weyburn-Midale	1.8 Mt CO <sub>2</sub> /yr commercial 2000	2000-2011	oil field carbonate EOR	Encana, Apache	IEA GHG R&D Programme, CSLF
North America, Canada, Alberta Zama oil field	250,000 tons CO <sub>2</sub> , 90,000 tons H <sub>2</sub> S demo	2005-2009	oil field carbonate EOR	Apache (Reg. Part.)	CSLF
North America, Canada, British Columbia Fort Nelson	> 1 Mt CO <sub>2</sub> /yr, 1.8 Mt acid gas/yr large-scale demo	2009-2015	saline formation	Spectra Energy (Reg. Part.)	CSLF
Europe, North Sea, Norway Sleipner	1 Mt CO <sub>2</sub> /yr commercial 1996	2002-2011	marine sandstone	StatoilHydro	IEA GHG R&D Programme, CSLF, European Com.
Europe, North Sea, Norway Snovhit CO2 Storage	700,000 tonnes CO <sub>2</sub> commercial 2008	2009-TBD	marine sandstone	StatoilHydro	
Europe, Germany CO2SINK, tzin	60,000 tonnes CO <sub>2</sub> demo 2008	2007-2010	saline sandstone	GeoForsch- ungsZentrum, Potsdam(GFZ)	CSLF, European Commission, IEA GHG R&D Prog
Australia, Victoria Otway Basin	100,000 tonnes CO <sub>2</sub> demo 2008	2005-2010	gas field sandstone	CO2CRC	CSLF
Africa, Algeria In Salah gas	1 Mt CO <sub>2</sub> /yr commercial 2004	2005-2010	gas field sandstone	BP, Sonatrach, StatoilHydro	CSLF, European Commission
Asia, China, Ordos Basin	assessment phase CCS	2008-TBD	Ordos Basin	Shenhua Coal	

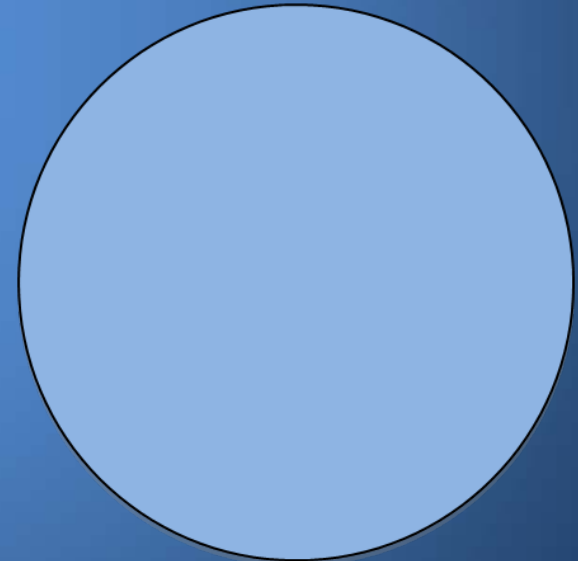
# Scale Matters

Total CO<sub>2</sub> stored globally



- Weyburn (2000)
- Sleipner (1996)
- In Salah (2005)
- Snohvit (2009)
- SECARB-Cranfield (2009)

Cumulative global CO<sub>2</sub> storage needed



# Large-Scale CCS Projects Are Needed to...

- Establish reliability and the “true” cost of CCS in commercial applications
- Support legal and regulatory framework development for large-scale geologic storage
- Reduce future CCS costs via learning-by-doing
- Reconcile continued use of fossil fuels with climate change mitigation

**For information on the nine large-scale CCS projects in the U.S. planned under the DOE Regional Sequestration Partnership Program:**

**[http://www.netl.doe.gov/technologies/carbon\\_seq/partnerships/partnerships.html](http://www.netl.doe.gov/technologies/carbon_seq/partnerships/partnerships.html)**

**THANK YOU!**