Evolving GHG Regulations, CCS and the Power Industry

1

Texas Carbon Capture and Storage Association

- TxCCSA committed to promoting energy security and environmental benefits through advancement of carbon capture and storage in Texas
- Includes a diverse coalition of utilities, oil and other energy producers, pipeline and emission trading companies, and environmental consultants
- Supports environmentally responsible energy production and advocates for market-based policies and incentives that encourage the development of a commercial carbon capture and storage industry in the state

2

What Are The Issues?

Hundreds Attend Global Warming Protest

3

Overview and Agenda

- What Are The GHG Rules For The Power Industry?
- What Is CCS And Why Should I Be Interested?
- What Does The Future Hold?

4

Background

- Almost Two Years Ago, Supreme Court's Decision: CO2 An "Air Pollutant" Within Clean Air Act (Mass. Vs EPA)
- Said EPA To Take Action
- Supreme Court's Direction To EPA- Choose One Of Three Paths:
  - Find That CO2 Causes Or Contributes To Air Pollution That Endangers Public Health Or Welfare
  - Find That It Does Not Cause Or Contribute To Air Pollution
  - Offer A Reasonable Explanation As To Why It Cannot Determine The Answer To That Question

5

What Are The GHG Rules For The Power Industry?

- GHG Monitoring – Subpart D (and C)
- Permits- Both PSD and NSPS
  - Endangerment and Tailoring Rules
  - Possible issues for Title V
    - GHG could be subject to CAA rules and therefore controls
- BACT for Power Industry

6

Some Terms

- EPA Has Issued Two Final Rules That Will Focus Clean Air Act Permitting For GHGs On The Largest Emissions Sources Including Electric Generating Units These Rules Include:
- Final State Implementation Plan (SIP) Narrowing rule for Prevention of Significant Deterioration (PSD) Permitting for Greenhouse Gases
- Use of Best Available Control Technology (BACT)
- Will Need to Implement -New Source Performance Standard (NSPS)

7

Subparts C/D

- Must report GHG emissions from all source categories located at their facility including stationary combustion (40 CFR part 98, subpart C) and process emissions .
- The methods presented typically account for normal operating conditions, as well as startup, shutdown, or malfunction (SSM)
- Although SSM is not specifically addressed for many source categories, emissions calculation methodologies relying on CEMS or mass balance approaches would capture these different operating conditions

8

Tailoring Rule

- Last April, EPA issued the tailoring rule to ensure that only the largest sources of GHGs (those responsible for 70% of the GHG pollution from stationary sources), would require air permits
- With these "narrowing" rules in place, federal rules will not require states to permit sources with GHG emissions below those established in the Tailoring Rule even if they have not been able to adopt the new levels into their SIP or approved operating permit program

9

Texas and PSD and NSPS

- EPA found that PSD permitting regulations in 13 states do not meet Clean Air Act requirements because their programs currently do not cover GHG emissions
- EPA also issued a "SIP call," which requires these states to revise their programs to ensure that their PSD programs cover GHG emissions
- The state of Texas did not select a SIP submittal date and, under the Clean Air Act, defaults to the latest possible date – December 1, 2011
- EPA is issuing a complementary series of actions that will assure PSD permitting in Texas can continue during this time without disruption for GHG emitting sources

10

BACT and Coal Fire Power Plants

- The EPA has issued documents to provide guidance in selecting a technology to reduce emissions from sources that must obtain a permit for a new facility or an existing one undergoing a major modification
  - 5 Steps
- For coal-fired power plants, the first type of technology that may be considered is fuel switching such as from coal to natural gas or biomass
- Another potential control method in the EPA guidance is carbon capture and storage (CCS)
- The last major area discussed is energy efficiency. For power plants, this may mean installing more efficient burners or other changes that increase energy efficiency
  - The EPA has indicated that energy efficiency will be the most likely technology required for most facilities that obtain GHG permits.

11

Some Complications

- Section 112 for MACT for all 189 HAPS
  - Maximum Achievable Control Technology
- If Every Coal Fired Power Plant To Put In Scrubbers ($350-500 Million In Investment)
  - For Small Units Under 200 MW and for Older Plants (Over 40 Years)
- For Small Plants- Could Be 17% Of Plants That May Need To Be Replaced Or Retired
- For Older Plants- Could be 28% Replaced or Retired
- Credit Suisse said 60 GW by 2017

12

What Is CCS?

- Carbon Capture And Storage
- Capture
- Transport
- Storage
  - Sequestration
  - EOR

  Example- Tenaska

13

What Is Carbon Capture and Storage (CCS)?

- Technologies exist that allow for CO_2 from the combustion or gasification of coal and other fossil fuels to be captured rather than released to the atmosphere
- Once captured, CO_2 can be injected into and stored permanently or long-term (i.e., for thousands of years) in underground geological formations
- Most cost-effectively applied to large stationary sources

14

Simple Overview of CCS

- 3 step process:
  - Stream of CO_2 is captured from flue gas or other process stream (purified as much as possible)
  - Compressed to about 100 atmospheres and transported by pipeline to the injection site
  - Injected deep underground into a geological formation

15

Carbon Capture-Hardest Step

- Capturing and compressing CO_2 requires much energy
- Increases the fuel needs of a coal-fired plant by 25%-40%
- 3 different types of technologies exist:
  - post-combustion, pre-combustion, and oxyfuel combustion
- *Post-combustion:* CO_2 removed after combustion of the fossil fuel- applied to conventional power plants
  - CO_2 captured from flue gases at large point sources. Technology is well understood but can be expensive for large scale

16

Carbon Capture-Hardest Step

- *Pre-combustion:* fossil fuel is partially oxidized (e.g. Gasifier) - Resulting Syngas (CO and H_2) into CO_2 and more H_2 and CO_2 captured before combustion
  - H_2 used as fuel- widely applied in fertilizer, chemical, gaseous fuel (H_2, CH_4), and power production
- *Oxy-fuel combustion:* fuel is burned in oxygen instead of air, cooled flue gas is re-circulated and injected into the combustion chamber. Flue gas consists of mainly CO_2 and water vapor, latter condensed through cooling.
  - Result : almost pure CO_2 stream, not a fraction, is removed from the flue gas stream (as in pre- and post-combustion capture) but is the flue gas stream itself
  - Technique promising, but initial air separation demands a lot of energy

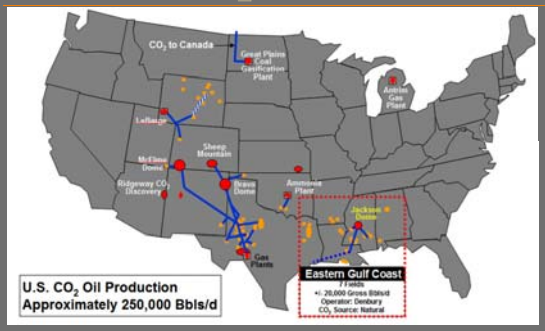
17

Carbon Transport

- After capture, the CO_2 must be compressed and transported to suitable storage sites
- Pipeline cheapest form of transport
- 2008 approximately 5,800 km of CO_2 pipelines in US- currently used to transport CO_2 to oil production fields for EOR

18

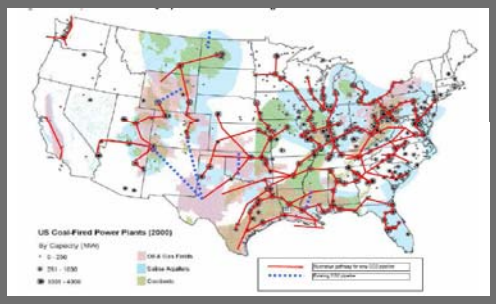
Current CO_2 Pipeline Network



19

High EOR CO_2 Pipelines

CARBON SEQUESTRATION & STORAGE: DEVELOPING A TRANSPORTATION INFRASTRUCTURE
Prepared for The INGAA Foundation, Inc. by: ICF International Feb 2009



20

Carbon Storage

- Storage Of The CO_2 Either In Deep Geological Formations, In Deep Ocean Settings, Or In The Form Of Mineral Carbonates
- Geological Formations Currently Considered The Most Promising Sequestration Site
- Also Known As *Geo-sequestration*, Involves Injecting Carbon Dioxide, Generally In Supercritical Form, Directly Into Underground Geological Formations such as:
  - Oil Fields, Gas Fields, Saline Formations, Un-minable Coal Seams, And Saline-filled Basalt Formations Have Been Suggested As Storage Sites
- Various Physical () and Geochemical Trapping Mechanisms Prevents The CO_2 From Escaping Numerous Natural Geological Traps Of CO_2 Exist In Nature

21

Carbon Storage & EOR Win-Win for Texas?

- Onshore Gulf Coast contains 18 billion barrels of stranded oil in portions of the Texas and Louisiana Gulf Coast basins and the Mississippi Salt basin
- Permian Basin contains another 18 billion barrels of oil potential
- Texas has 40% of the U.S. opportunity to recover CO_2 EOR oil barrels in the reservoirs
- Gulf Coast in Particular: Potentially up to 10 billion additional barrels when the results extrapolated to all oil reservoirs in the area

22

Tenaska Trailblazer Energy Center

- Announced February 2008
- 600 MW net pulverized coal plant
- Post-combustion CO_2 capture
  - 85 to 90% capture rate (300 MMSCFD)
- CO_2 sold for use in enhanced oil recovery (EOR)
  - 5.75 million tons/year
  - 11.5 million BBLs incremental oil production per year
- Total capital cost: $3.5 billion

23

Progress Report

- Project partner/coal supplier
- Engineering, procurement, construction contractor
- CO_2 capture technology & FEED study
- GCCSI grant
- Dry cooling
- Transmission
- Air permit

24

Arch Coal, Inc.

- March 2010
- 35% equity interest in Trailblazer
- 2nd largest U.S. coal producer
- Trailblazer's fuel supplier
  - 3.5 million tons per year of low-sulfur coal from the Powder River Basin area of Wyoming
  - First 20 years of commercial operations

25

Fluor Corp.

- EPC contractor
  - June 2009
  - Preliminary design and specifications
- CO2 Capture Technology
  - July 2010
  - Fluor's Econamine FG Plus^{sm}
  - 8 month CO_2 FEED study

26

Water Conservation

- First large-scale Texas coal-fueled power plant to use "dry cooling"
- Reduces water usage by more than 90%
- Average use 1 million gallons/day
- Maximum use 2 million gallons/day
- Legally binding agreement with Environmental Defense Fund

27

Transmission

- Tenaska filed an interconnection request with ERCOT
  - February 2008
- ERCOT's Generation Interconnect Screening Study
  - No negative impact to the region's transmission system
  - September 2008
- Trailblazer will help stabilize the West Texas transmission grid by providing power 24x7

28

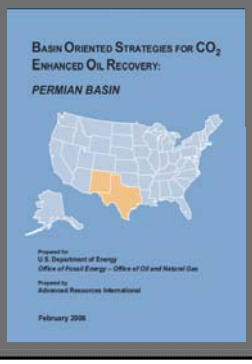
Air Permit

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

- Air permit application with TCEQ
  - February 2008
- TCEQ draft air permit: *"the emissions of air contaminants from the proposed facility will not violate any state or federal air quality regulations and will not have any significant adverse impacts on soils, vegetation or visibility."*
  - February 2009
- SOAH ALJs issued Proposal for Decision
  - October 1, 2010
- Final Permit Issued

29

Permian Basin EOR Potential



- Significant amount of stranded oil
- CO_2-EOR allows recovery of a large portion of that stranded oil
- 21 billion barrels of recoverable oil through CO_2-EOR
- Large volumes of CO_2 will be required to achieve this EOR potential

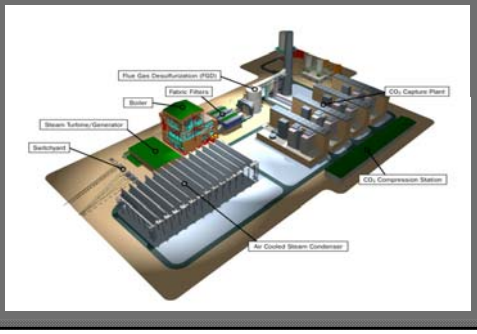
30

Trailblazer: A Regional Project With Regional Benefits

- Construction will inject more than $742 million in economic activity in Nolan County and provide over 1,500 jobs at peak
- Operation will add 105 jobs at the plant with an average annual salary of $75,000 and about 71 jobs in the community
- Would increase taxable property value by 50% in Nolan County
- EOR from the plant's CO_2 would increase annual Permian Basin oil production by over 11.5 million barrels per year.

31

www.tenaskatrailblazer.com



32

What Does The Future Hold?

- EPRI
- Economist
- UT Law Conference
- White Papers
- Madame Gypsy

33

Quick Summary

- Global energy demand will increase by about 35% in 2030 from 2005 levels as natural gas becomes the world's second-largest energy source behind oil
- Use of gas and other less carbon-intensive forms of energy, combined with greater energy efficiency, will help mitigate the higher demand's environmental impacts
- "The forecasts show a shift toward gas as businesses and governments look for reliable, affordable, and cleaner ways to meet energy needs,"
- "Newly unlocked supplies of shale gas and other unconventional energy sources will be vital in meeting this demand."

34

More Predictions

- "The ramp-up in gas production which now has the US looking at a 100-year supply because of technological breakthroughs all occurred without policies or subsidies; The industry simply put its head down and developed new technologies in response to market forces
- " CCS is happening in Texas and EOR has been going on for decades. We have the experience and it can be a win-win for the State"
- Rising electricity demand, and the choice of fuels to generate that electricity, will have a major impact on the global energy landscape in the next two decades

35

More Predictions

- Global electricity demand in 2030 will be more than 80% higher than it was in 2005 as rapid economic growth and expanding prosperity in developing countries outside the OECD push their demand upward by 150%
- "Oil, gas, and coal remain dominant, but coal's share will shrink because of growing consumption of gas, driven by demands to reduce greenhouse gas emissions"
- "Coal will continue to play an important role for our fossil fuel needs and the solution is all of the above in regards to the type of energy the country will need"

36

More Information

- GHGs Issues (epa.gov)
- For viewing via the EPA website at http://www.epa.gov/live
- For CCS www.txccsa.org
- For Tenaska www.tenaska.com

37