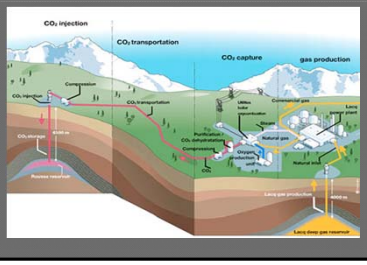
Evolving GHG Regulations, CCS and Texas



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Texas Carbon Capture and Storage Association

- TxCCSA committed to promoting energy security and environmental benefits through advancement of carbon capture and storage in Texas
- Association- 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

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Overview and Agenda

- What Are The GHG Rules That Affect the US and Texas?
- What Is CCS And How Can It Impact Energy Issues?
- What Does The Future Hold?

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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

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What Are The GHG Rules For Texas Industries ?

- Federal GHG Monitoring – Subpart D (and C) –Power Industry
- GHG Monitoring- Subparts W,X and Y- Oil and Gas Industries
  - *Subpart X Petrochemical Production , Subpart Y Petroleum Refinery, Subpart W Oil and Natural Gas Systems*
- GHG Monitoring- Subpart PP and RR - CO2 Producers and Suppliers

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Subparts C/D

- Must report GHG emissions from all source categories located at power plants including stationary combustion units and process emissions
  - Report to EPA each year
- Present a monitoring and reporting plan
- Emissions calculation methodologies for CEMS or mass balance

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Subparts For Oil and Gas

- Must report GHG emissions from all source categories located at their facilities including stationary combustion units and process emissions
- Report by direct measurements or engineering calculations
- Data used to calculate GHG emissions (CH4 and CO2) categorized by fuel or material type
  - Actual GHG emissions calculations and methods
  - Analytical results for HHV, CC, fuel or feedstock parameters
  - Facility operating or process data used for GHG calculations

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Subpart PP

- Capture Facilities – i.e. facilities that capture for commercial use or sequestration
  - CO_2 production wells
- Importers and Exporters of CO_2
- Report Production Quantities Captured from:
  - Production process units
  - CO_2 production wells

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Subpart RR – Carbon Dioxide Injection and Geologic Sequestration

- Two-tiered reporting system
  - First tier will apply to both EOR and GS facilities
  - Second tier will apply only to GS facilities
- First tier - three requirements
  - EOR and GS sources must report the amount of CO2 injected underground
  - Facilities are required to report the mass of CO2 transferred on-site from offsite sources
  - Facilities are required to report their CO2 supply source, if known.
- Second-tier requirements only apply to GS facilities
- Must report: (1) amount of CO2 leaked to the surface after injection; (2) amount of CO2 produced in oil or gas (active EOR operations); (3) amount of fugitive and vented CO2 emissions from surface equipment (unless these emissions are reported another Subpart and (4) the calculated total amount of sequestered CO2.

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Additional Requirements- 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.

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What Is CCS?

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

Example- Tenaska

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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

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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)
    - Conventional approach is wet scrubbing with amine solution, but takes lot of energy
  - Compressed to about 100 atmospheres and transported by pipeline to the injection site
    - If use refrigerated NH3 for capture reduces energy need to compress for pipeline use
  - Injected deep underground into a geological formation

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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
  - Amine or NH3

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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

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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

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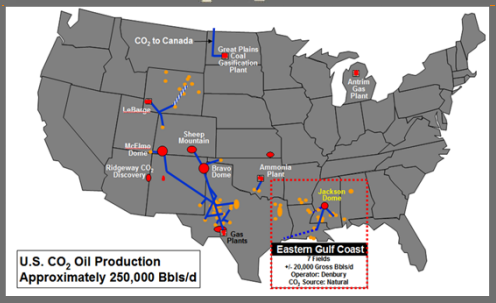
Current CO_2 Pipeline Network



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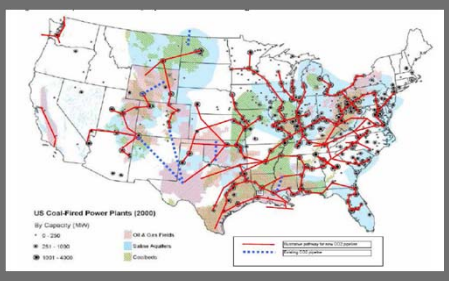
High EOR CO_2 Pipelines

CARBON SEQUESTRATION & STORAGE: DEVELOPING A TRANSPORTATIONINFRASTRUCTURE

Prepared for The INGAA Foundation, Inc. by: ICF International Feb 2009



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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

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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

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EOR and ROZ

- All reservoirs have oil-to-water transition zones, of varying thicknesses-origin to capillary forces
- Forces cause gradational changes in the oil and water saturations beneath the main pay zone
- Much larger "stranded" oil targets exist in residual oil zones of non-capillary origin
- Thicker and more extensive residual oil zones stem from displacement of oil previously trapped in oil reservoir

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Tenaska Trailblazer- Example Capture Project

- 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

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Progress Report

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

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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

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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



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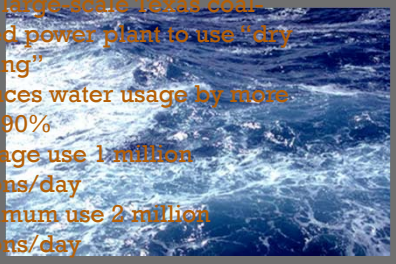
Water Conservation

- 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



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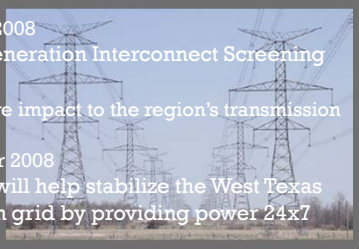
Transmission

- 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



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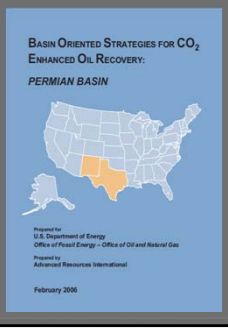
Permian Basin EOR Potential



- 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

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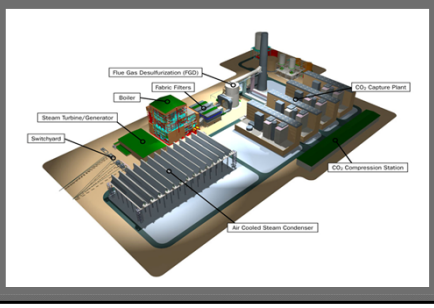
www.tenaskatrailblazer.com



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What Does The Future Hold?

- For Texas
- By "Experts"

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Texas Regulations

- Rules for injection of CO2 administered by RRC
- New rules authorizing injection and storage of anthropogenic carbon dioxide in oil and gas reservoirs, depleted reservoirs, potentially productive reservoirs and certain saline formations
- First in US to come out with rules for CO2 sequestration

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Energy Outlook

- " 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
- 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
- "Newly unlocked supplies of shale gas and other unconventional energy sources will be vital in meeting this demand."

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More Information

www. txccsa.org

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