

The Evolution of the EERC's Energy and Environmental Programs and Global, National, and Regional Perspectives, Challenges, and Opportunities

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Gerald Groenewold
Director




What Does the EERC Do?

- The EERC is recognized as one of the world's leading developers of:
 - Cleaner, more efficient and innovative energy technologies to guarantee clean, reliable energy supplies for the United States and the world.
 - Environmental technologies to protect and clean our air, water, and soil.
- The EERC is a research, development, demonstration, and commercialization (RDD&C) center.
- The EERC vigorously maintains a nonadvocacy position.
- The EERC enhances **any** guarantee.
- The EERC is **NOT** an academic enterprise.




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 **EERC** The International Center for Applied Energy Technology
Putting Research into Practice

WORLD-CLASS WORLD-CLASS
EXCELLENCE
TECHNOLOGICAL INNOVATION
AND CLEAN OUR
WATER AND SOIL

**“Don’t invent something
that nobody wants!”**


– Thomas Edison

 THE UNIVERSITY OF
NORTH DAKOTA

**THE EERC’S DEFINITION OF
“PEER REVIEW”**

IS THE PRIVATE SECTOR INVESTING
CASH IN OUR VARIOUS PROGRAMS?

THE MARKET MUST PULL TECHNOLOGY.

 **EERC** The International Center for Applied Energy Technology
Putting Research into Practice

EERC Research, Development, Demonstration, and Commercialization



Over 245,000 square feet of state-of-the-art facilities.

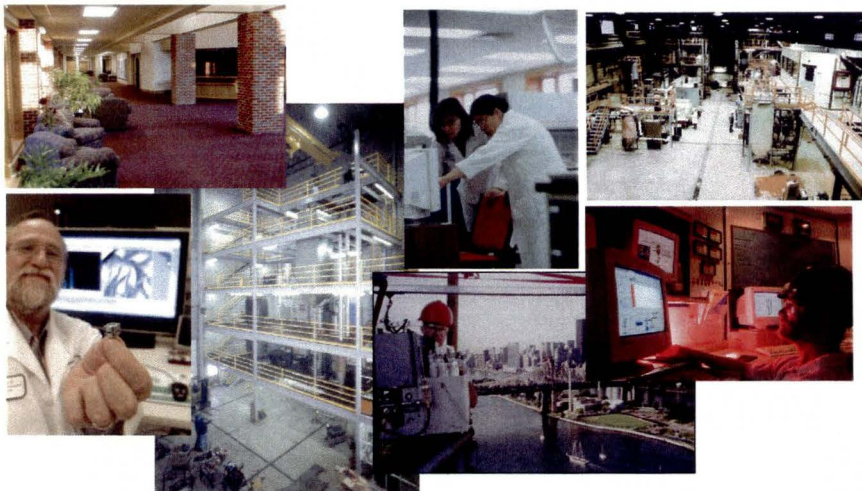
**“... the road to energy independence runs right through
Grand Forks and up to the front doors of the EERC.”**

—U.S. Senator Byron Dorgan



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EERC Facilities



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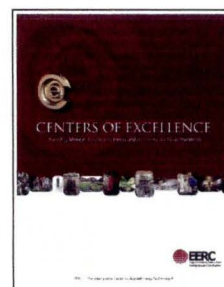
The EERC Conducts Field Projects Across North America



EERC Centers of Excellence

The EERC's Centers of Excellence are leading the world in providing expertise in scientifically advanced energy systems and the prevention and cleanup of air, water, and soil pollution.

- Coal Utilization Technologies Center
- Center for Oil and Gas
- Emission Control Technologies Center
- The National Center for Hydrogen Technology®
- Center for Climate Change, Carbon Capture, and Storage
- Center for Air Toxic Metals® (CATM®)
- Centers for Renewable Energy and Biomass Utilization
- Water Management Center
- National Alternative Fuels Center®
- Great Plains Applied Energy Technology Center®
- Center for Environmental Chemistry and Reclamation



EERC Research Portfolio Evolution

The EERC provides practical, cost-effective solutions to today's most critical energy and environmental issues and challenges.

Top Areas 2002

- Clean coal technologies
- Alternative fuels
 - Ethanol, biodiesel, 100% renewable diesel and jet, including strategic fuels for the military
- Emission control
 - SO_x, NO_x, air toxics, fine particulate
- Mercury measurement and control
- Wind energy
- Water management
- Flood prevention
- Contaminant cleanup

Top Areas 2012

- Clean coal technologies
- Alternative fuels
 - Ethanol, biodiesel, 100% renewable diesel and jet, including strategic fuels for the military
- CO₂ capture and storage
- Energy and water sustainability
- Distributed power generation – various fuels
- Oil exploration and production technologies
- Natural gas production and utilization technologies
- Biomass utilization

Other Strategic Areas

- Global climate change
- Hydrogen technologies
- Waste utilization
- Advanced analytical/extraction technologies



EERC
Energy Environment and Policy

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The Culture of the EERC

Cornerstone: Freedom, Not Security

- At the EERC, we have the freedom to pursue our dreams—but they must be practical, entrepreneurial, and market-driven dreams.
- A culture of partnerships.



EERC
Energy Environment and Policy

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A Unique Entrepreneurial Culture

Emphasizing True Working Partnerships

Key Partners

- Industry
- Government
- The research community

Key Attributes

- Willing to assume risk
- Innovative
- Tenacious
- Practical
- Market-driven



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Willingness to Assume Risk



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Worldwide Clients



Since 1987, the EERC has had 1213 clients in all 50 states and 51 countries.

Client Specs:

- Private corporations: 905
- International market: 155
- Government: 98
- Academia: 55

EVERY CONTRACT IS A COMMERCIALIZATION ACTIVITY



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The EERC Has Pioneered a Market-Driven Approach to RDD&C

The energy industry is focused on the growing demand for more efficient and economical techniques for a variety of fuels.

The environmental field is challenged with the growing demand for the cleanup and control of pollutants and environmental hazards.



EERC

Energy & Environmental Research Centers



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EERC Foundation Complements the EERC Business Model by Commercializing Technologies



- Commercialization is facilitated through the EERC Foundation, a nonprofit corporation formed in 1992.
- The EERC excels through partnerships with clients in industry and government to develop, refine, demonstrate, and commercialize marketable technologies that provide practical solutions to real-world problems.
- The EERC specializes in jointly sponsored research projects and multiclient consortia between government and industry.
- Facilitating confidentiality agreements is a cornerstone of the EERC's commercialization activities.



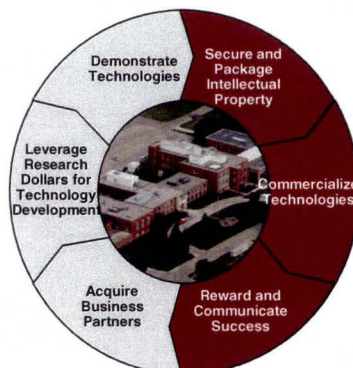
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The EERC Has Pioneered a Market-Driven Approach to Energy and Environmental RDD&C

A Seamless Transition...



Value Creation



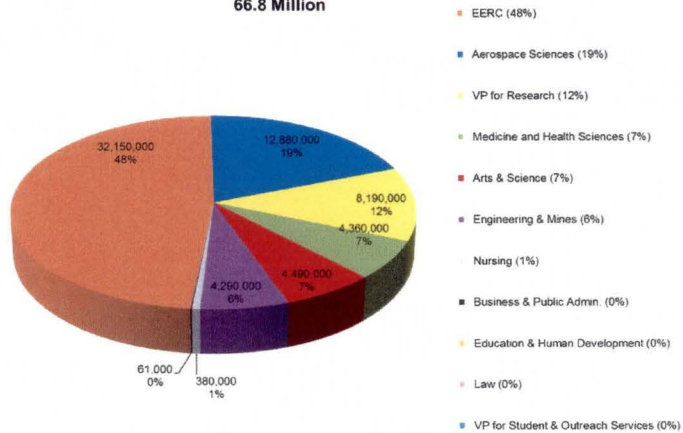
Value Realization



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Total UND Research Funding FY2012

Total UND Research Funding FY2012
66.8 Million



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FEDERAL EARMARKS

The EERC's philosophy regarding
"earmarks":

INVESTMENT CAPITAL
NOT ENTITLEMENT



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The EERC's philosophy regarding "earmarks" is recognized as a national model for strategic joint venture investment of federal funding leveraging private sector funding.



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Federal Funding Scenario Changes

- In FY2005–2009, the EERC received Congressionally "earmarked" funding of approximately \$10 million annually; key programmatic element was a U.S. Department of Energy (DOE)-funded "Joint Venture Program" focused on long-term precommercial R&D.
- In FY2011 and FY2012, the EERC received NO "earmarked" funding.
 - The EERC's current portfolio reflects near-term priorities of industrial clients and DOE.
 - The EERC has lost considerable latitude to explore long-term, visionary, precommercial R&D.



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Primary Power Consumption Today Is Approximately 85% Fossil Fuel-Derived

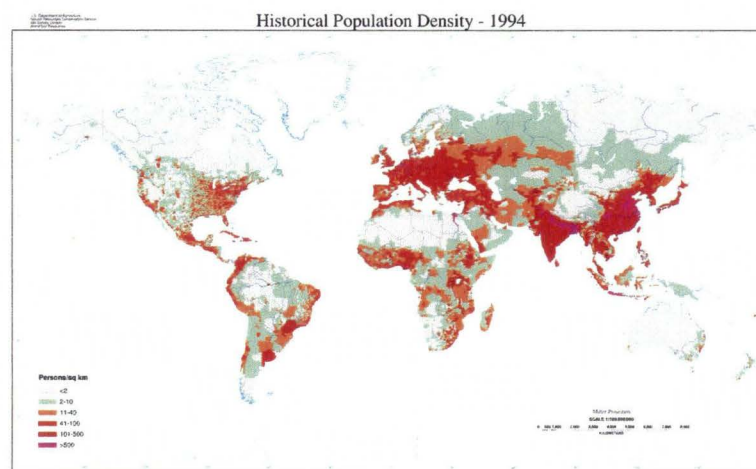


Source: *Science* 2002, 798 (1). Photo from National Aeronautics and Space Administration.



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Human Population Has *Quadrupled* and Energy Consumption Has *Increased Sixteenfold* in the 20th Century



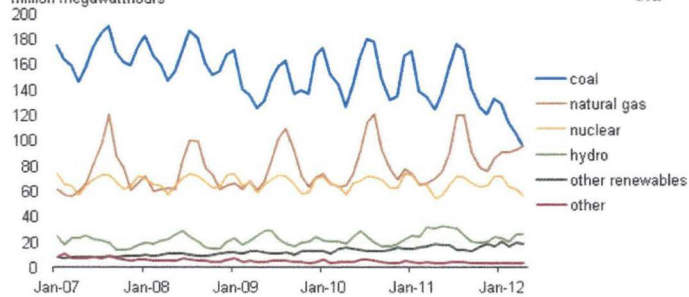
Source: *Science* 2002, 798 (1). Map from U.S. Department of Agriculture Natural Resources Conservation Service.



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Coal under Siege

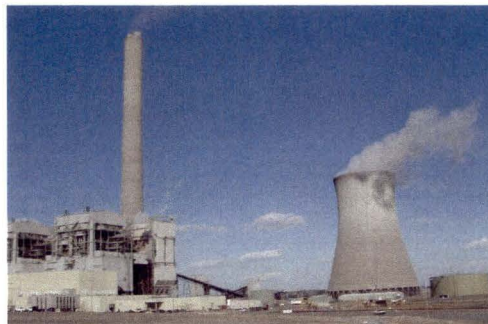
U.S. monthly net electric power generation, January 2007 – April 2012
million megawatthours



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Backdrop: Coal Power Plants

- August 2012 – U.S. Energy Information Administration
 - 27 GW of capacity from 175 coal-fired generators will be retired between 2012 and 2016.
 - Amounts to 8.5% of total 2011 coal-fired capacity.



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Domestic Coal-Fired Power Production Decline

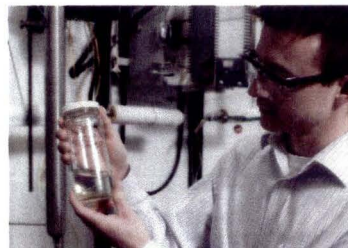
- Power plant decline:
 - Recession
 - U.S. Environmental Protection Agency (EPA) regulations
 - High cost of meeting New Source Review (NSR).
 - Organized opposition from environmental interests.
 - U.S. shutting down several power plant units per week.
- BUT coal mining not as obvious in decline:
 - Some U.S. and international coal mines maintaining sales.
 - Steel industry and exports.
 - Investment in rail and ports.



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The Key Is to Sustain Coal Use Through Innovative Utilization

- Coal is a sector that needs help
- Innovative utilization
 - Coal-biomass to liquids (CBTL)
 - Gasification for syngas
 - Hydrogen production
 - Gas cofiring with coal
 - Chemicals and fertilizer
 - Upgrade for domestic power and steel and export by overcoming quality issues: ash, slag, emissions, dust, and moisture



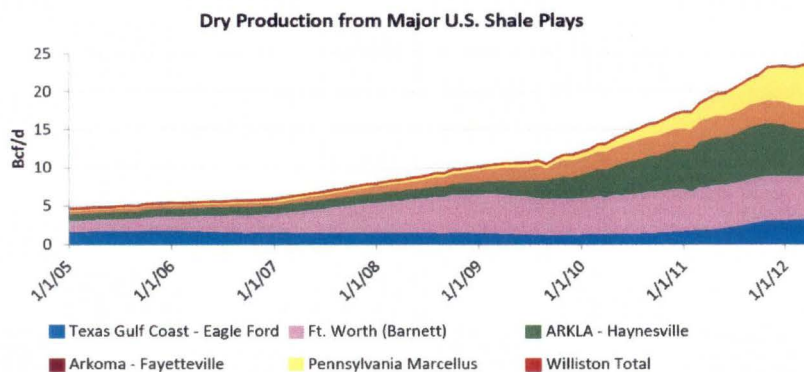
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Awash in Gas



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Changing Gas Paradigm



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Current U.S. Wind Resource

- American Wind Energy Association (AWEA) 2011 Annual Market Report
 - U.S. wind industry installed 6816 MW in 2011.
 - 31% increase from 2010.
 - ~3% of electric power generation – 2011; 46,916 MW.
- Wind was No. 2 new power source after natural gas.
- Low natural gas prices created more efficient business.
- 75,000 people employed in the U.S. wind energy sector.
- South Dakota and Iowa: >10% electricity from wind; others with relatively high wind energy use included North Dakota, Minnesota, and Wyoming.
- Five to 23 turbine manufacturers 2005–2011.
- Production Tax Credit (PTC) ends 2012.



Cooperstown, ND



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Biomass: What's Over the Horizon?

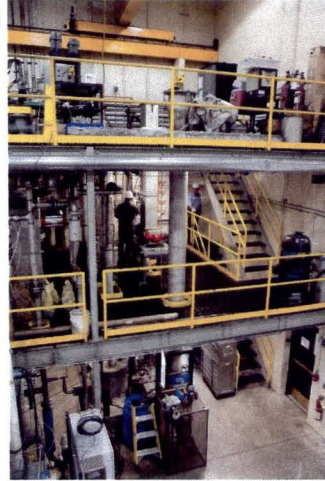
- Energy crops that make sense and contribute.
- Incentives – Renewable Portfolio Standard (RPS) initiatives, Renewable Fuels Standard (RFS) 2, and grassroots greenhouse gas (GHG) reduction help to sustain.
- Cofired or comixed for power and liquid fuels to lower carbon footprint has good potential.
- Distributed biomass-based power systems **that work** are possible.
- Still being proven technologically at commercial scale.



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Distributed Biomass Gasification Power Systems

- Interest in well-contained gasification-based power plant for distributed power
- EERC R&D to prototype and design engineering systems
- 100–500-kW biomass-powered systems burning clean syngas in large internal combustion engine generators
 - Poultry litter
 - Clean forest wood system for remote Arctic regions
 - Manufacturing and food waste residues conversion
- Liquid fuels for remote areas

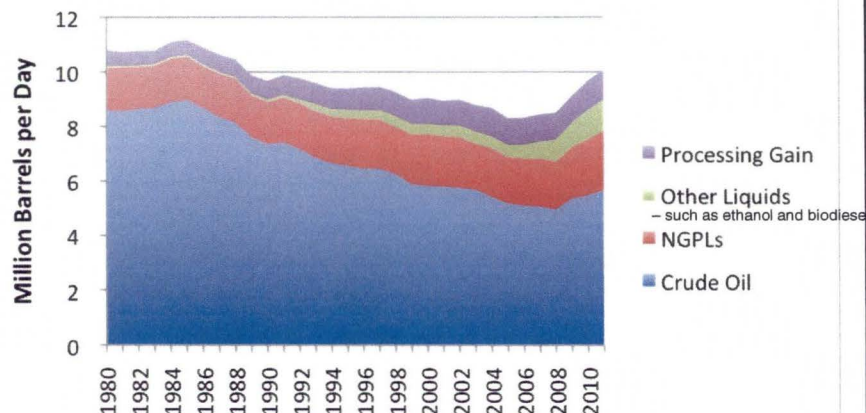


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Domestic “Liquid” Production Up 21% since 2005

US Oil and Other Liquids Production



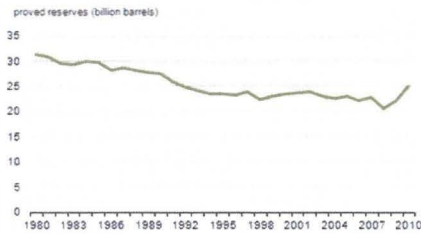
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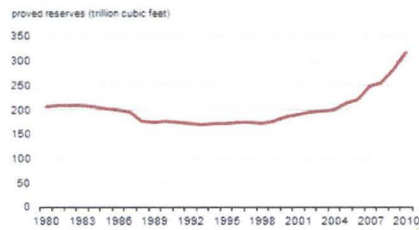
Source: <http://www.theoil Drum.com/node/9106>
 Accessed August 23, 2012, "Based on EIA Data"

Growing U.S. Reserves...

Figure 1 U.S. oil and natural gas proved reserves
U.S. crude oil and lease condensate proved reserves



U.S. wet natural gas proved reserves



Source: U.S. Energy Information Administration, U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves, 1980 through 2010 annual reports

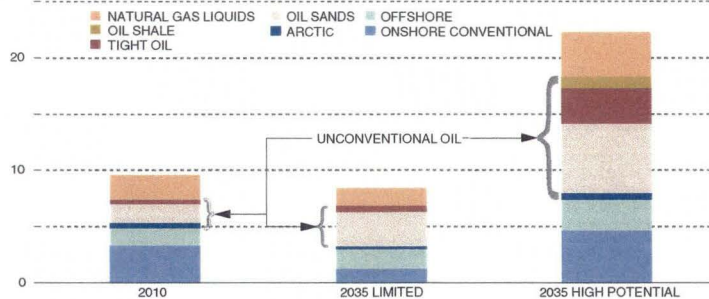
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North American Hydrocarbon Independence?

Resource Access and Technology Innovation
Can Substantially Increase North American Oil Production



IT'S ALL DEPENDENT ON POLICY

- Factors that may constrain or enable development and production.
- **Whether access is enabled.**
- **Infrastructure is developed.**
- **Appropriate technology research and development is sustained.**
- **An appropriate regulatory framework is in place.**
- **Environmental performance is maintained.**



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*Current U.S. and Canadian oil consumption estimated at 21.5 million bbl/day.
Source: Historical data from Energy Information Administration and National Energy Board of Canada.

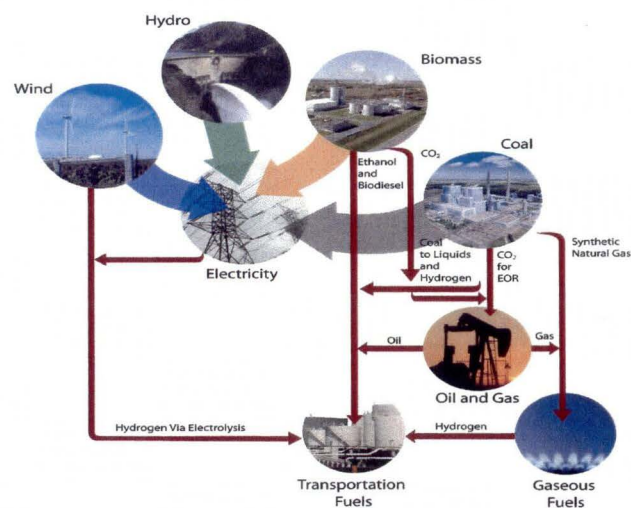
North Dakota Energy Business

- Utilizing combinations of renewable, fossil, and CO₂ storage resources could be critical for future energy growth.
- Need demonstration of coal, gas, and biomass with carbon capture and storage (CCS) or carbon capture utilization and storage (CCUS).
 - Perfect storm of success.
 - Immense resource portfolio.
 - Future CO₂ regulations or markets may require bold action resulting in huge North Dakota opportunity.
 - Permanent CO₂ storage, EOR, and other carbon markets.
 - Coal-biomass to liquids with CCUS to develop and sustain new industries.



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Opportunity for Energy Synergy



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The Challenge

***“Human history more and more
becomes a race between
education and catastrophe.”
– H.G. Wells***



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Thank you!



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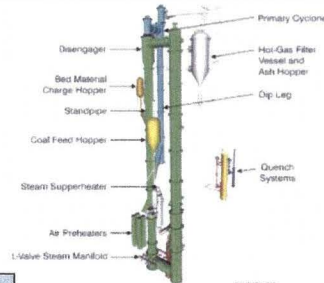
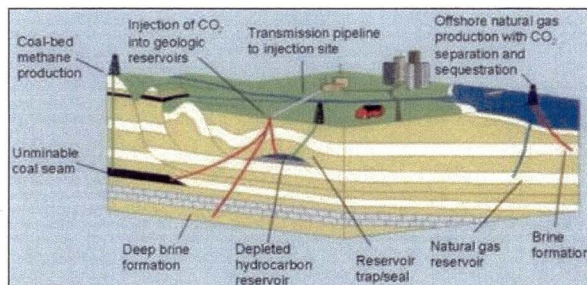
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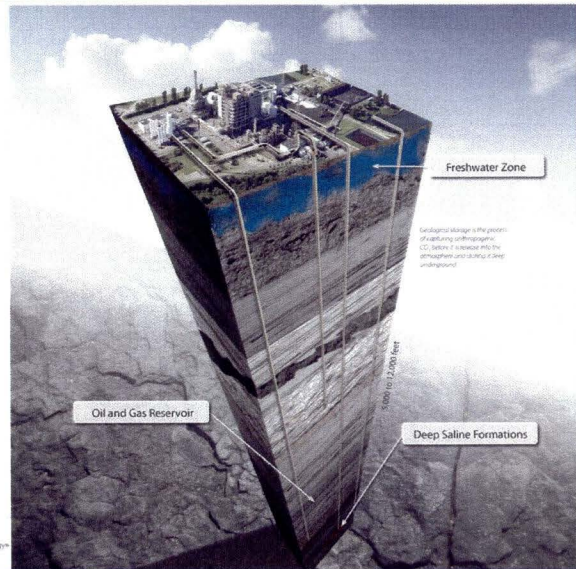
Methods for Reducing Greenhouse Gas (GHG) Emissions

- Renewable energy technologies
- Advanced high-efficiency energy systems
- Improve efficiency of existing systems
- Reduce consumption of energy
- Clean fossil energy technologies
- **Carbon Capture Utilization and Storage (CCUS)**



CO₂ Storage Options

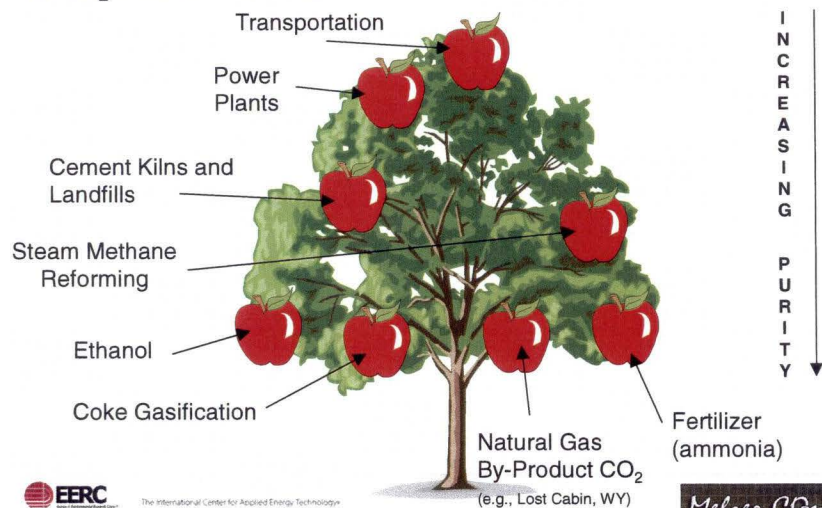
- Saline formations
- Oil and gas fields:
 - Storage in association with CO₂-based enhanced oil recovery (EOR)
 - Storage in depleted oil and gas fields



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Industrial CO₂ Sources

"The CO₂ Source Fruit Tree"



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Melzer Consulting