Approved: March 31, 2004
Date

MINUTES OF THE HOUSE ENVIRONMENT COMMITTEE

The meeting was called to order by Chairperson Joann Freeborn at 3:30 p.m. on March 9, 2004 in Room 231-N of the Capitol.

All members were present except:
Representative Gary Hayzlett- excused
Representative Larry Powell- excused

Committee staff present:
Emalene Correll Legislative Research Department
Raney Gilliland Legislative Research Department
Mary Ann Graham, Committee Secretary

Conferees appearing before the committee: Tim Carr, Chief of Petroleum Research, Kansas Geological Survey, Kansas University, 1930 Constant Ave.,Lawrence, KS 66047-3726

Others attending:
See Attached List.

Chairperson Joann Freeborn called the meeting to order. She reviewed the committee agenda for Thursday, March 11, a hearing on **SB416** - Allows cities and counties to use certain moneys for programs dealing with recyclables and a hearing on **SB396** - Creates the radiation control operations fee fund. She asked if there was a motion to approve committee minutes for January 20, 22, 27, 29, and February 3, which had been distributed to committee members on Friday, March 5, for review.

Rep. Lee Tafanelli made a motion the committee minutes for January 20, 22, 27, 29, and February 3, be approved. Rep. James Miller seconded the motion. Motion carried.

Chairperson Freeborn welcomed Tim Carr, Chief of Petroleum Research, Kansas Geological Survey, Kansas University. He reviewed Geologic Carbon Sequestration, with the use of overhead slides. He provided background on green house gases (GHG) and geologic sequestration, that may have a large potential on the Kansas economy and tax base. Most energy used to meet human needs is derived from the combustion of fossil fuels (natural gas, oil, and coal), which releases carbon to the atmosphere, primarily as carbon dioxide (CO2). Based on the forecasts (e.g., EIA, IEA), fossil fuels will continue to be the primary source of energy for our advanced economies well into the middle of this century. While the processes are still not well understood, the atmospheric concentration of CO2, a greenhouse gas, is increasing. This raises concerns that solar heat will be trapped and the average surface temperature of the Earth will rise in response. There is the potential that CO2 and other GHG's may in the future be considered pollutants. It is not within his scientific expertise of interests to argue the merits of global climate change and the need to control GHG's such as CO2. However, it is within his interests to look for environmentally and economically prudent management of our energy resources that benefits Kansas. They are working to understand carbon management within integrated energy systems. Their focus is on geologic sequestration, but within a context of providing economic access to energy for Kansas. Sequestration encompasses all forms of carbon storage, including storage in terrestrial ecosystems, geologic formations, and oceans. Through the development of optimized field practices and technologies, the program seeks to quantify and improve the storage capacity of all potential reservoirs. Sequestration Goals: Expand the number and type of carbon sequestration opportunities in Kansas; Lower the cost and optimize the value-added benefits associated with CO2 storage; Develop field and management practices to minimize seepage and promote permanence of storage; and Develop capability to assess capacity for carbon storage. (See attachment 1) Committee questions and discussion followed.

Chairperson Freeborn thanked Mr. Carr for his presentation and thanked committee members and guests for their attention.

The meeting adjourned at 4:25 p.m. The next meeting is scheduled for Thursday, March 11, 2004.

HOUSE ENVIRONMENT COMMITTEE

DATE March 9, 2004

NAME	REPRESENTING
Tim Carr	Kansas Geological Survey
Dale Lambley	KDA
Charles Benjamin	Sierra Club
Kevin Parks	Sierra Club

Testimony before the House Environment Committee 3/7/04

Written Testimony – Images attached as separate file.
All material available as Kansas Geological Survey Open-File Report 2004-10
Online at http://www.kgs.ku.edu/PRS/publication/ofr2004-10/Testimony.pdf

Chairperson Freeborn and Members of the Committee:

My name is Timothy R. Carr. I am Chief of the Energy Research Section of the Kansas Geological Survey, and Co-Director of the Energy Research Center at the University of Kansas. I do not come as an advocate of any legislation before the committee, but to provide background on green house gases (GHG) and geologic sequestration, that may have a large potential on the Kansas economy and tax base. I will attempt to place the technical, environmental and economic aspects of control of green house gas and geologic sequestration within a national, state and local perspective

Most energy used to meet human needs is derived from the combustion of fossil fuels (natural gas, oil, and coal), which releases carbon to the atmosphere, primarily as carbon dioxide (CO_2). Based on the forecasts (e.g., EIA, IEA), fossil fuels will continue to be the primary source of energy for our advanced economies well into the middle of this century. While the processes are still not well understood, the atmospheric concentration of CO_2, a greenhouse gas, is increasing. This raises concerns that solar heat will be trapped and the average surface temperature of the Earth will rise in response. There is the potential that CO_2 and other GHG's may in the future be considered pollutants. It is not within my scientific expertise or interests to argue the merits of global climate change and the need to control GHG's such as CO_2. However, it is within my interests to look for environmentally and economically prudent management of our energy resources that benefits Kansas. We are working to understand carbon management within integrated energy systems. Our focus is on geologic sequestration, but within a context of providing economic access to energy for Kansas.

Sequestration encompasses all forms of carbon storage, including storage in terrestrial ecosystems, geologic formations, and oceans. Through the development of optimized

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Attachment 1

field practices and technologies, the program seeks to quantify and improve the storage capacity of all potential reservoirs.

Sequestration Goals

- **Expand the number and type** of carbon sequestration opportunities in Kansas
- **Lower the cost** and optimize the value-added benefits associated with CO_2 storage
- **Develop field and management practices** to minimize seepage and promote permanence of storage
- **Develop capability to assess** capacity for carbon storage

There are several types of geologic formations in which CO_2 can be stored. These formations have provided natural storage for crude oil, natural gas, brine, and CO_2 over millions of years. And in more recent years, people have injected municipal and even hazardous waste for long-term storage. Each type of formation has its own mechanism for storing CO_2 and a resultant set of technical questions and opportunities. Many power plants and other large point sources of CO_2 emissions in Kansas are located near geologic formations that are amenable to CO_2 storage. Further, in many cases injection of CO_2 into a geologic formation can enhance the recovery of oil and gas, which can offset the cost of CO_2 capture. The major types of geologic reservoirs that are being investigated for near-term use as CO_2 sequestration sinks are:

- Oil and Gas Pools / Fields
- Coal Beds
- Deep Saline Aquifers
- Unconventional Reservoirs - tight gas sands; organic shales; salt domes, etc.

The use of CO_2 to enhance oil and gas recovery is a common industrial practice. CO_2 is widely acknowledged as one of the best mediums to use for enhanced oil recovery. CO_2 enhanced oil recovery (EOR) has been in commercial practice since the 1970s. In 2000, 34 million tons of CO_2 were injected underground as part of EOR operations in the United States. This is roughly equivalent to the CO_2 emissions from 6 million cars in one year. For EOR, 5 mcf CO_2 are typically ultimately stored per additional barrel oil recovered. These injection operations take place in the southwest portion of the US using CO_2 produced from naturally occurring geologic reservoirs. Most of the US and Kansas does not have known large CO_2 reservoirs to use for enhanced recovery operations. Thus, application of CO_2 capture-technology and geologic sequestration could provide an affordable source of CO_2 for enhanced recovery operations that could provide a much-needed stimulus to the oil and gas industry. Nearly a billion barrels of oil might be producible via CO_2 enhanced recovery operations within Kansas. Research and development in this area will move the technology forward to make it applicable to a wider range of formations.

A novel process is the injection of CO_2 into coalbeds that are not minable, thus releasing the trapped methane. This process is called Enhanced Gas Recovery (EGR) or Enhanced CoalBed Methane production (ECBM), and is similar to using CO_2 injection to enhance production from oil reservoirs. With EGR, the injected CO_2 is adsorbed by the coal and stored in the pore matrix of the coal seams, releasing the trapped methane that can be sold for profit. Future work in the area can lead to the design of efficient null-greenhouse-gas-emission industrial facilities (e.g., landfills and cement kilns) and power plants that are fueled either by minable coal or by the methane released from the deep coal reservoirs. In this closed CO_2 process, the waste CO_2, produced from the coal or methane-powered plants, is injected into the CBM reservoirs to produce more methane, and the cycle continues. A geological sink is established in the coal beds, virtually eliminating any release of CO_2 to the atmosphere. Coal-bed methane is the fastest growing source of US and Kansas natural gas supply. Although there are no commercial deployments of CO_2-enhanced CBM recovery these is active and promising area of technology development, and eastern Kansas is uniquely situated with large industrial sources of CO_2 directly overlying active coalbed methane production.

Saline and depleting gas formations do not offer the value-added benefit of enhanced hydrocarbon production, but the potential CO_2 storage capacity of domestic saline formations is huge; estimates are on the order of several hundred years of CO_2 emissions. There is one commercial deployment in Norway, where one million tons of CO_2 per year are injected in a saline formation at the Sleipner natural gas production field in the North

Sea. Disposal of industrial waste fluids in geologic formations is a widely accepted practice; one that is a large part of the solutions that have led to cleaner surface waters in the US and worldwide. Thus, using the deep subsurface saline formations to help cleanse our biosphere is not a new concept.

The Kansas Geological Survey and the KU Energy Research Center are out in the field, in the lab and using the Internet working to better understand the potential of geologic sequestration to enhance the environmental and economic benefits of integrated energy systems to Kansas. The Russell, Kansas Integrated Energy System Project is an example of linking agriculture, energy production, and geologic sequestration to provide economic benefits while minimizing our impact on the environment. Other projects in the planning stages include using deep unminable coal beds to process landfill gas and cement kiln emissions, sequester CO2 while increasing methane production. Another project that is just being organized is FutureGen. FutureGen is an attempt to build a zero emission coal-fired power plant with the next decade. A significant component of FutureGen will be geologic sequestration of CO2 produced by the power plant.

We see all these projects as systems approaches to energy production that can provide environmental and economic benefits to Kansas. These projects have the potential of value-added sequestration of greenhouse gases may be as valuable as primary production in a possible carbon constrained world. Energy production has been a foundation of our Kansas economy for more than 100 years. Based on published forecasts from the International Energy Agency and the Energy Information Administration, hydrocarbons (oil, gas and coal) will remain the primary source of energy through the middle of the 21st century. Kansas has a bright energy future, and integrated energy systems can help to insure that future.

Geologic CO_2 Sequestration in Kansas

Presented to:
House Environment Committee
March 9, 2004

Presented by:
Timothy R. Carr
tcarr@kgs.ku.edu

March 9, 2004

Outline

- Overview of Green House Gas (GHG) Sequestration
  - Terrestrial, **Geologic**, Ocean, Other
- Kansas CO_2 Emissions,
  - Challenges and Opportunities
  - Value-Added Approach
- State of the Technology
  - Current Projects
    - Russell Kansas
    - CO_2 Partnerships
  - Planned Projects
    - Cement Flue Gas
    - Landfill Gas
  - Potential Projects
    - FutureGen

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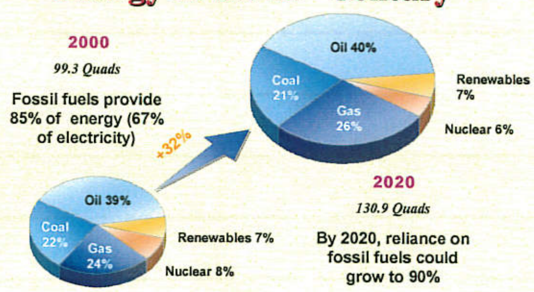
Fossil Energy Foundation for Energy in the 21st Century



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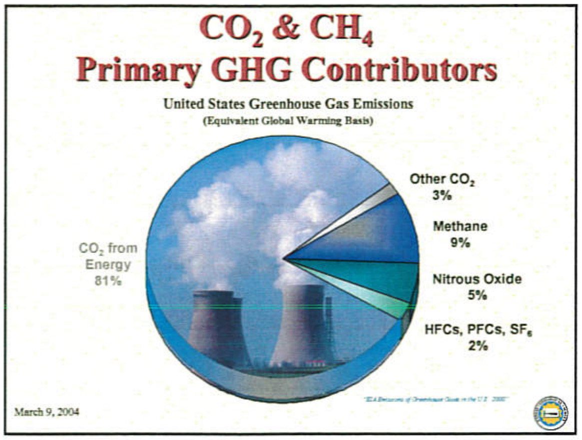
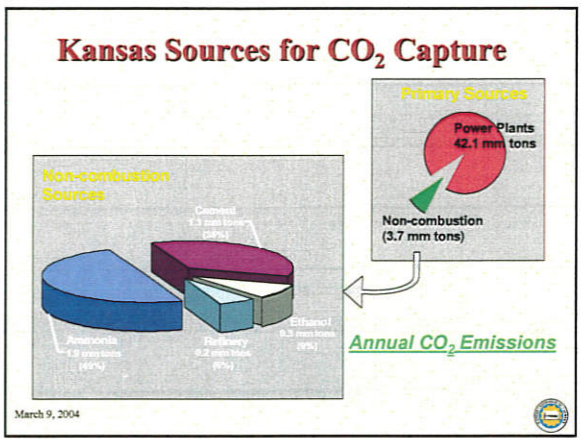
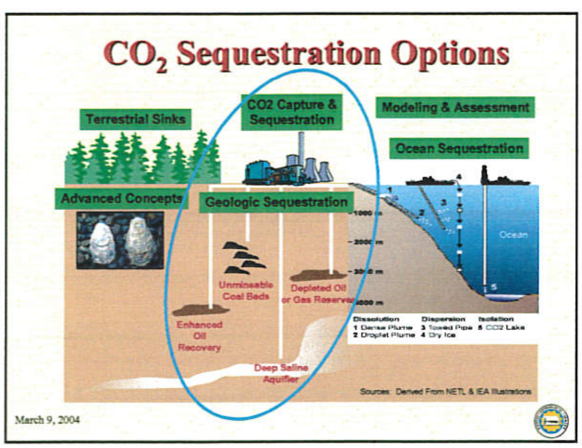

CO_2 & CH_4
Primary GHG Contributors
United States Greenhouse Gas Emissions
(Equivalent Global Warming Basis)
CO_2 from Energy 81%
Other CO_2 3%
Methane 9%
Nitrous Oxide 5%
HFCs, PFCs, SF_6 2%
March 9, 2004


Kansas Sources for CO_2 Capture
Primary Sources
Power Plants 42.1 mm tons
Non-combustion (3.7 mm tons)
Non-combustion Sources
Cement
Ammonia
Refinery
0.2 mm tons
Ethanol
0.3 mm tons
Annual CO_2 Emissions
March 9, 2004


CO_2 Sequestration Options
Terrestrial Sinks
CO2 Capture & Sequestration
Modeling & Assessment
Ocean Sequestration
Advanced Concepts
Geologic Sequestration
Unmineable Coal Beds
Depleted Oil or Gas Reserves
Enhanced Oil Recovery
Deep Saline Aquifer
Ocean
Dissolution
1 Dense Plume
2 Droplet Plume
Dispersion
3 Towed Pipe
4 Dry Ice
Isolation
5 CO2 Lake
Sources: Derived From NETL & IEA Illustrations
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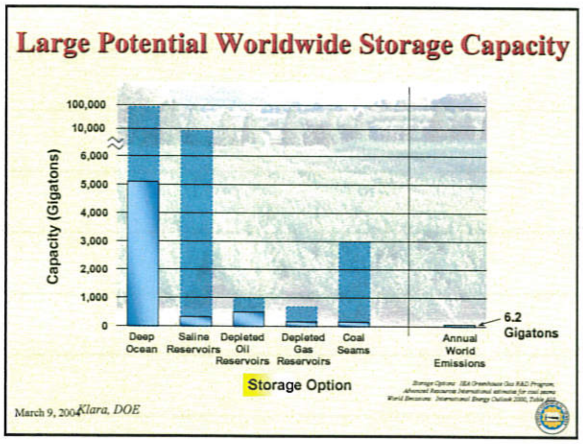
Large Potential Worldwide Storage Capacity
Capacity (Gigatons)
100,000
10,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Deep Ocean
Saline Reservoirs
Depleted Oil Reservoirs
Depleted Gas Reservoirs
Coal Seams
Annual World Emissions
6.2 Gigatons
Storage Option
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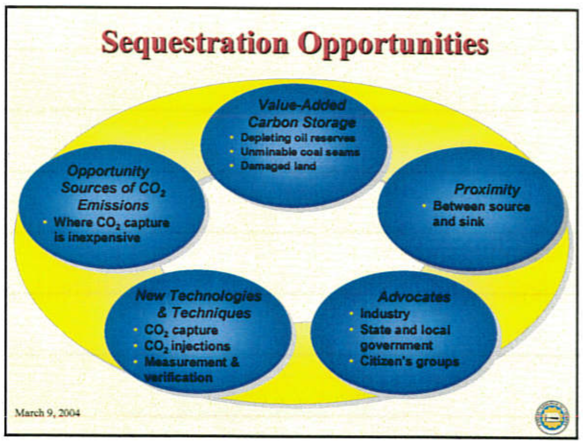
Klara, DOE


Sequestration Opportunities
Value-Added Carbon Storage
Depleting oil reserves
Unminable coal seams
Damaged land
Opportunity Sources of CO_2 Emissions
Where CO_2 capture is inexpensive
Proximity
Between source and sink
New Technologies & Techniques
CO_2 capture
CO_2 injections
Measurement & verification
Advocates
Industry
State and local government
Citizen's groups
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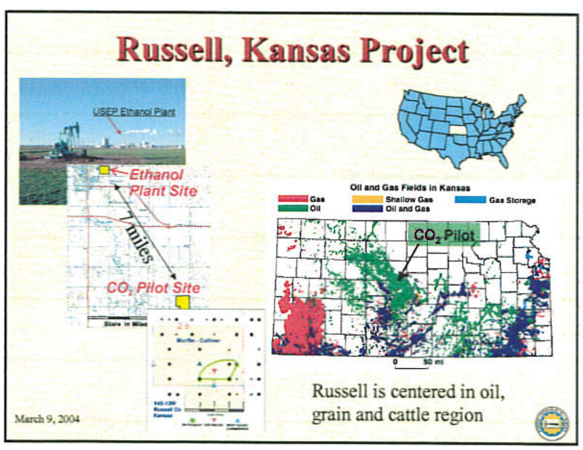
Russell, Kansas Project
USEP Ethanol Plant
Ethanol Plant Site
7 miles
CO_2 Pilot Site
Oil and Gas Fields in Kansas
Gas
Oil
Shallow Gas
Oil and Gas
Gas Storage
CO_2 Pilot
0 50 mi
Russell is centered in oil, grain and cattle region
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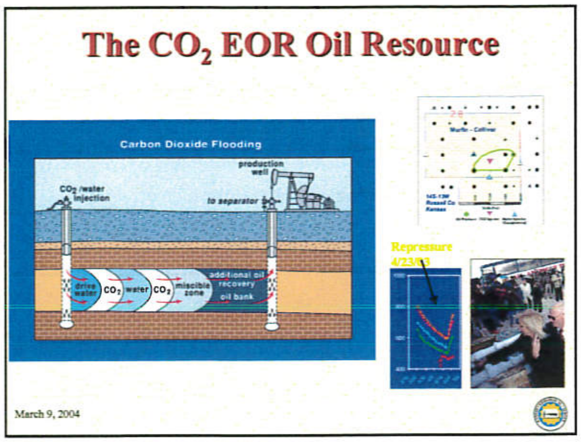
The CO2 EOR Oil Resource
Carbon Dioxide Flooding
production well
CO2 /water injection
to separator
drive water
CO2
water
CO2
miscible zone
additional oil recovery
oil bank
Repressure
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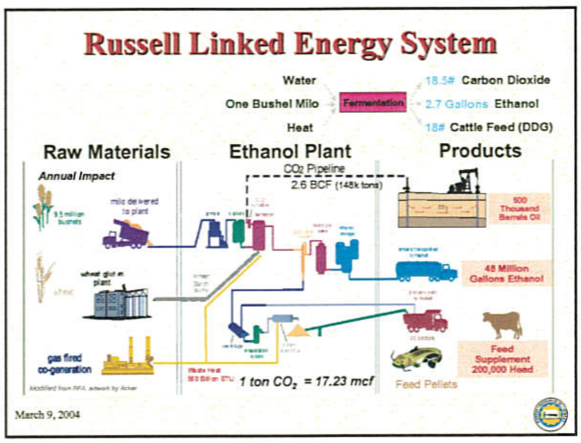
Russell Linked Energy System
Water
One Bushel Milo
Heat
Fermentation
18.5# Carbon Dioxide
2.7 Gallons Ethanol
18# Cattle Feed (DDG)
Raw Materials
Annual Impact
Ethanol Plant
Products
CO2 Pipeline
2.6 BCF (148k tons)
500 Thousand Barrels Oil
48 Million Gallons Ethanol
Feed Supplement 200,000 Head
Feed Pellets
gas fired co-generation
1 ton CO2 = 17.23 mcf
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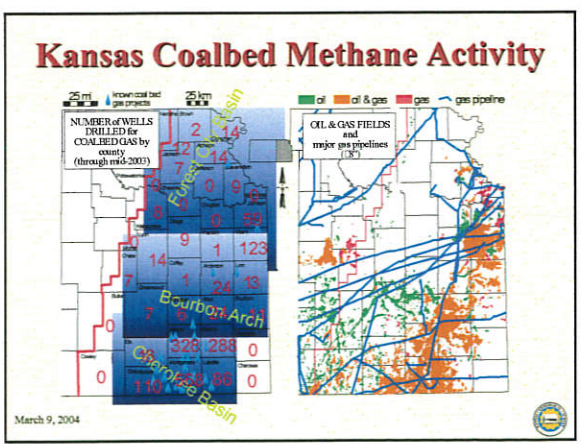
Kansas Coalbed Methane Activity
25 mi
25 km
known coal bed gas projects
NUMBER of WELLS DRILLED for COALBED GAS by county (through mid-2003)
Forest City Basin
Bourbon Arch
Cherokee Basin
oil
oil & gas
gas
gas pipeline
OIL & GAS FIELDS and major gas pipelines
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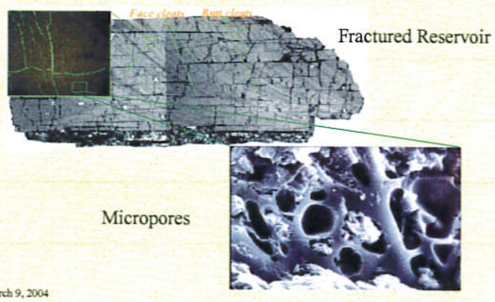
Coal, an Unconventional Reservoir



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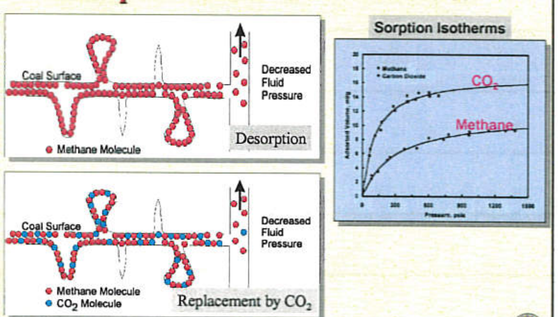
Methane Production from Micropores and ECBM Production



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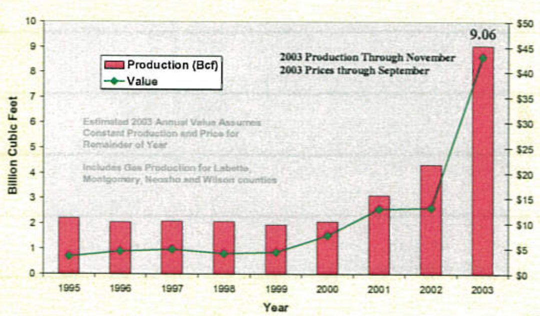
SE Kansas CBM Production



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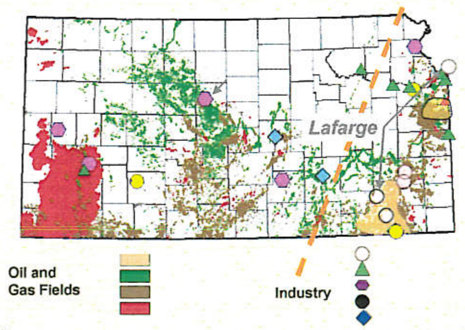
1-9

Kansas Industrial CO_2 Sources



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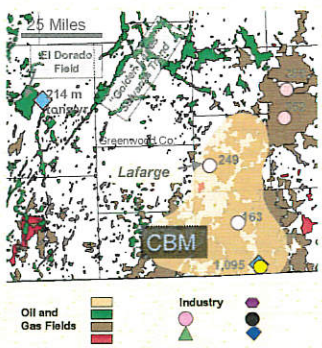
Southeast Kansas

Partially miscible and immiscible CO_2 EOR
- El Dorado
- Salyards Trend,

Enhanced Coalbed Methane (N_2 and CO_2)

Cement plant gas stream may be best suited for ECBM



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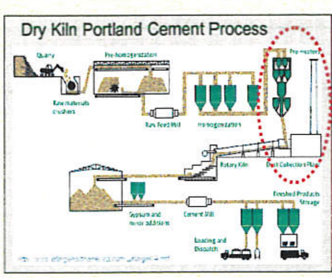
Cement Production



Calcination Process
$CaCO_3 > CaO + CO_2$
0.51 tons CO2 / ton cement

CO_2 and N_2 kiln gas mix may be suitable for ECBM with little processing

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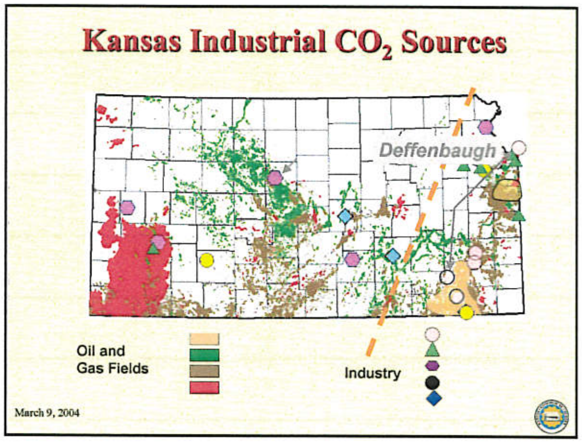
Kansas Industrial CO_2 Sources
Deffenbaugh
Oil and
Gas Fields
Industry
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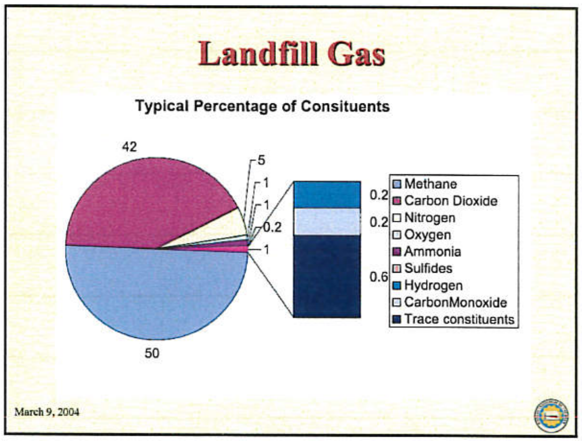
Landfill Gas
Typical Percentage of Consituents
42
5
1
1
0.2
1
50
0.2
0.2
0.6
Methane
Carbon Dioxide
Nitrogen
Oxygen
Ammonia
Sulfides
Hydrogen
CarbonMonoxide
Trace constituents
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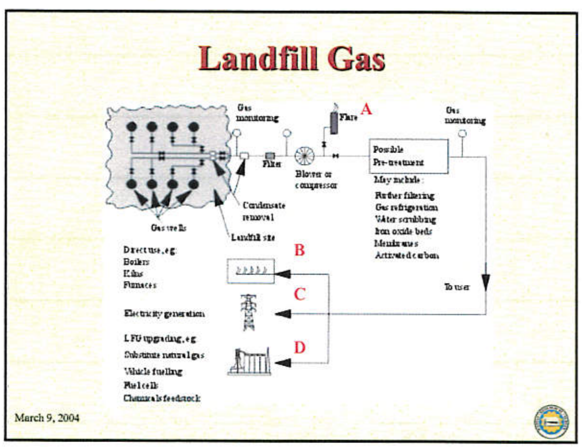
Landfill Gas
Gas monitoring
Flare
A
Gas monitoring
Filter
Blower or compressor
Possible Pre-treatment
May include:
Further filtering
Gas refrigeration
Water scrubbing
Iron oxide beds
Membranes
Activated carbon
Condensate removal
Gas wells
Landfill site
B
C
D
To user
Electricity generation
Vehicle fuelling
Fuel cells
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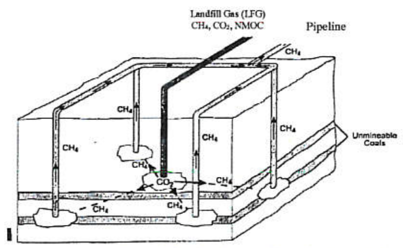
Landfill Gas



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FutureGen

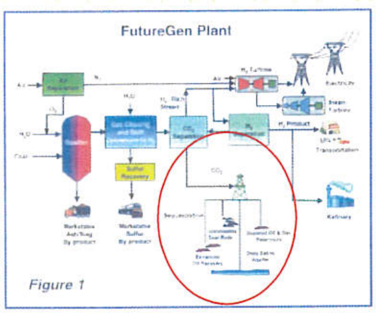

Figure 1

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Expected Program Costs

Project Definition	$ 20MM
Engineering & Procurement	60MM
Plant Construction	360MM
Sequestration Design/Construction	320MM
Plant Operation	220MM
Total	**$1000MM**

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Coffeyville, Kansas, Petroleum Coke Gasification Plant

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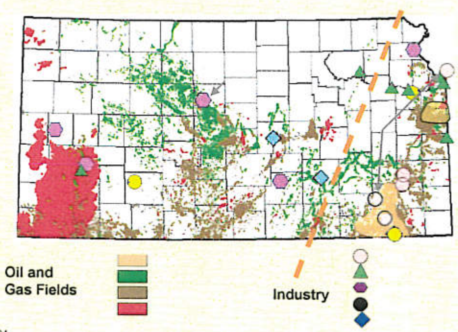
Kansas Industrial CO_2 Sources



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CO_2 Trivia

- **1 ton CO_2 = 17.23 mcf**
- **1 tonne CO_2 = 18.95 mcf**
- **5 mcf CO_2 / BO (Net utilization: *Sequestered?*)**
- **Combustion of 1 barrel of oil yields 8 mcf (.46 ton) CO_2**
- **Perspective:**

  US Annual Anthropogenic Emissions 6.3 Billion tons
  KS Annual Anthropogenic Emissions 46 Million tons
  An average human exhales 5.6 mcf (1/3 ton) CO_2/ yr

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