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EERC Technology... Putting Research into Practice

Future of Coal in North Dakota

Presentation to the North Dakota Legislative Council
Interim Energy Development and Transmission Committee
October 24, 2007

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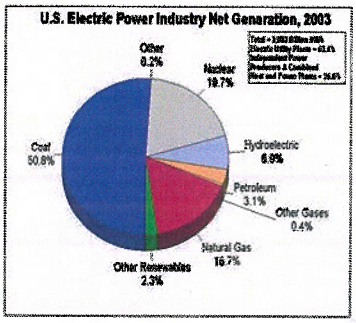
U.S. Electric Generation



www.eia.doe.gov/neic/brochure/elecinfocard.html

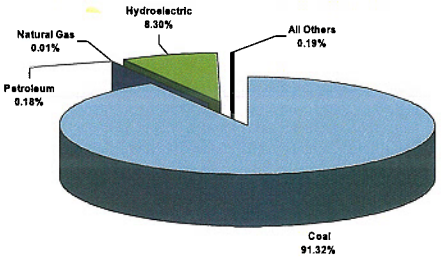
Electrical Generation by Source (DOE/EIA 2006)

	2004	2020	2030
Billion kWh	3955	5108 +1.6%/yr	5926 +0.6%/yr
		Source, %	
Coal	51%	50%	58%
Nuclear	20%	17%	15%
Natural Gas	18%	22%	17%
Renewable	9%	9%	9%
Petroleum	3%	2%	2%

Electrical Generation and Annual Growth by Source (DOE/EIA 2006) (cont.)

- The projected increase in generating capacity is 250,000 MW through 2030.
- Coal accounts for half of the net change in kilowatts generated between 2004 and 2020 and all of the net change between 2020 and 2030 because of decreased use of natural gas.
- Coal production increases from 1125 million tons in 2004 to 1355 million in 2020 and to 1703 million in 2030. 96% of the increase through 2020 is for power generation.
- Three quarters of the increased coal production through 2030 is western coal.

1999 North Dakota Electricity Generation by Fuel

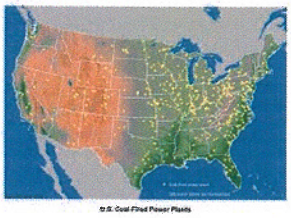


Sources: Energy Information Administration, Form EIA-759, "Monthly Power Plant Report"; Form EIA-867, "Annual Nonutility Power Producer Report"

Comparison of State per Capita Production of Energy

	ND Rank	No. 1 State	% Increase Necessary to Be No. 1
Wind	5	WY	500
Coal	3	WY	1300
Oil	3	AK	1000
Natural Gas	4	WY	2600
Electricity	4	WY	80
Ethanol	12	SD	400
TOTAL ENERGY	6	WY	1000

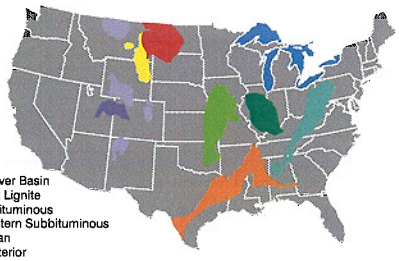
Coal Fired Power Plants in the U.S.



- About 1,300 coal-fired generation units (~ 500 coal-fired power plants), representing about 305 GW of generation capacity
- Existing Controls:
  - Almost all units have particulate matter (PM) control devices
  - About one-third of capacity has SO_2 scrubbers
  - Most have initial NOx controls (low-NOx burners)
  - About one-third of the capacity (primarily in the east) will have advanced NOx control (SCR) when NOx SIP call is fully implemented

Source: U.S. EPA

Map of Coal Basins in the United States



- Powder River Basin
- Gulf Coast Lignite
- Western Bituminous
- Other Western Subbituminous
- Appalachian
- Eastern Interior
- Western Interior
- Fort Union Lignite

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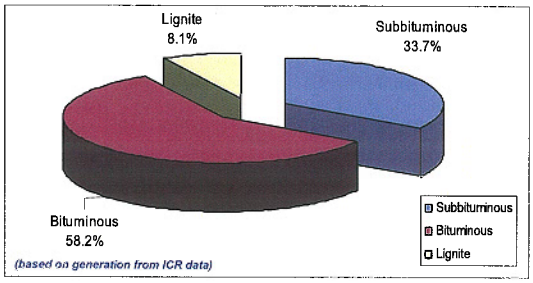
Distribution of Coal Used by Power Plants in United States



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North Dakota Coal Resources

- Western North Dakota contains an estimated 351 billion tons of lignite, the single largest deposit of lignite known in the world, underlying nearly 40% of the state.
- North Dakota contains an estimated 25 billion tons of economically minable coal.
  - Enough to last for over 800 years at the present mining rate of 32 million tons per year
  - Recovered from surface mines in beds that vary in thickness from 3 to 30 feet

Currently, there are six operations mining in western North Dakota, four of which mine lignite for use in electrical power generation.

Lignite 101

Properties of Lignite	Commercial Value
Low energy value/lb	-
High moisture	-
High reactivity	+
Medium sulfur	-
High ash (inorganics)	-
Low mining costs	+

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Lignite Utilization 101

Lignite Utilization Issues	Commercial Value
Higher capital cost	-
Higher environ. perform. cost	-
Low fuel cost	+
High transportation cost	-
Low CO_2 Efficiency (CO_2/MW)	-
Good Collocation with CO_2 Sinks	+

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Future of Coal (Tom's "Topics of Change")

National "Topics"

1) Greenhouse gases
2) Water
3) Combustion versus gasification
4) Environmental performance
5) Transmission
6) Electricity vs. fuels

North Dakota "Topics"

1) Transmission
2) Greenhouse gases
3) Environmental performance
4) Water
5) Combustion versus gasification
6) Electricity versus fuels
7) Energy synergy

"They always say time changes things, but you actually have to change them yourself."

– Andy Warhol, The Philosophy of Andy Warhol

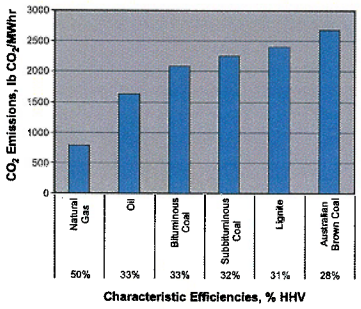
Topic: Transmission

- ???
- ???
- Complexity of grid
- Nobody wants to ~~pay~~ be responsible for it – Orphan issue
- NIMBY
- Liquid fuels
- Hydrogen
- Synthetic natural gas

"A countryman between two lawyers is like a fish between two cats."

– Benjamin Franklin

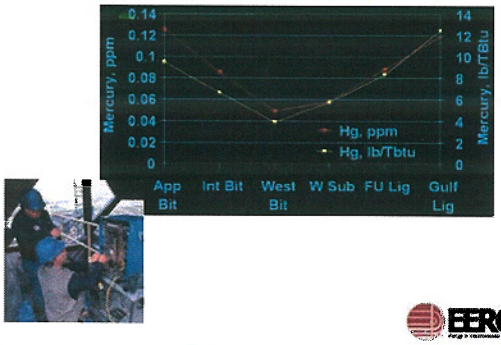
Topic: CO_2 Emissions



Topic: Environmental Performance

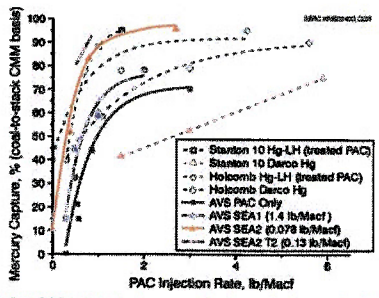
- All environmental performance issues are solvable; the only question is to what level and at what cost.
  - NO_x
  - SO_x
  - Mercury
  - Particulate
  - Mine land reclamation

Mercury in Coal



Significant Progress on Hg Control for Western Coals

Comparison – Parametric Tests at Three SDA–FF Sites (PRB and lignite)*

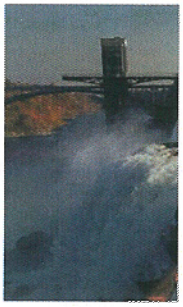


With support from DOE, industry has been proactive in preparing for pending federal (CAMR) and state regulatory limits on mercury emissions.

* Comparisons with data from DOE NETL Web Site.

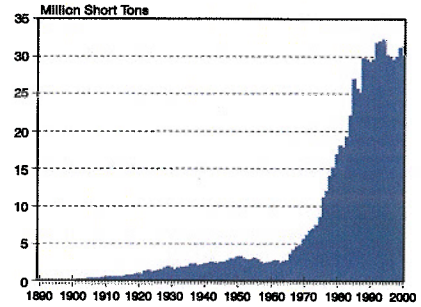
Topic: Energy and Water

- Conventional coal power generation is second only to agriculture as the largest user of water in the United States:
  - 39% of all freshwater withdrawals in the United States.
- 131,900 million gal/day of water is used.
- All regions of the United States are vulnerable to water shortages.
- Recent technology developments:
  - Flue gas water extraction.
  - Dry and hybrid cooling systems.



Continued availability and efficient use of water resources are critical to the future growth of the energy industry.

Annual History of North Dakota Coal Mined – Energy and Water Sustainability



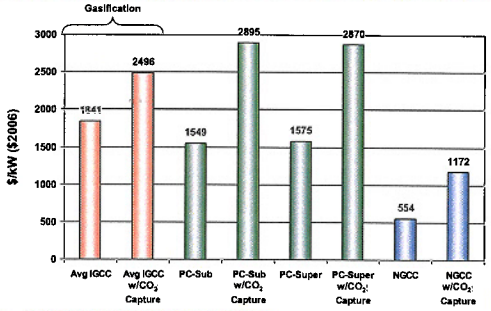
ND state statistics publicly available at www.oilgas.nd.gov/stats/statisticsvw.asp.

Topic: Combustion vs. Gasification

- Current coal gasification systems are acknowledged to cost more than conventional coal-fired plants (EPRI, 2006).
- **Carbon capture and sequestration**, if required, may make coal gasification the least cost option for new coal-fired power generation.
- **NEAR-ZERO TO ZERO EMISSIONS**

Transport Gasifier

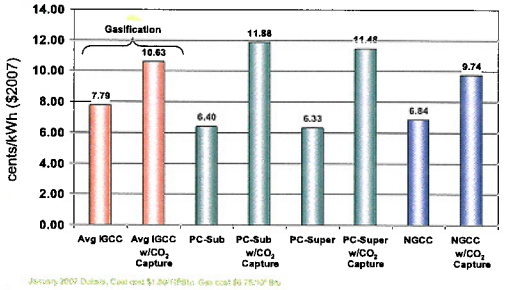
Total Plant Cost Comparison



Total Plant Capital Cost includes contingencies and engineering fees

http://www.netl.doe.gov/energy-analyses/baseline_studies.html

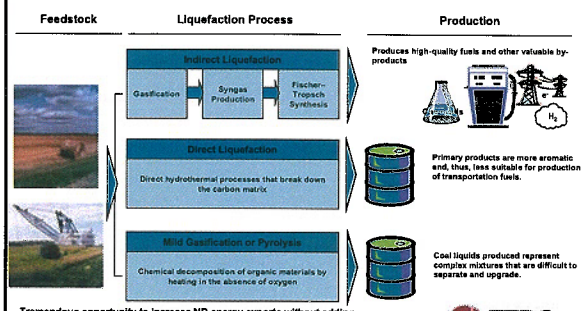
Cost of Electricity Comparison



January 2007 Dollars. Coal cost $1.84/MMBtu. Gas cost $6.75/MMBtu

http://www.netl.doe.gov/energy-analyses/baseline_studies.html

Topic : Liquefaction of Coal and Biomass

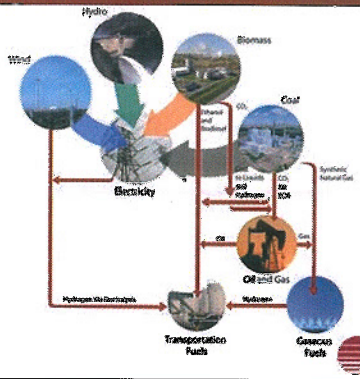


Tremendous opportunity to increase ND energy exports without adding transmission capacity. Includes advanced tactical fuels for the military, fuels for energy markets, and specialty chemicals.

Liquefaction of Coal and Biomass

- Indirect liquefaction is currently the only economical technology for producing liquid fuels from coal or biomass, cost-effective at approximately $40–$50/barrel.
- The process is similar to the existing Great Plains Synfuels facility except instead of producing a synthetic natural gas, the facility would produce a liquid fuel via Fischer–Tropsch synthesis.
- Future coal gasification systems could be built to produce three energy sources: electricity, liquid fuel, and hydrogen.
- There are no commercial plants in the United States; however, Sasol has been doing this for many years in South Africa, and other countries are currently building facilities.

Topic: Energy Synergy



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