



Indiana Center for Coal Technology Research
Located in the Energy Center at Discovery Park, Purdue University

INDIANA COAL is Economic Growth

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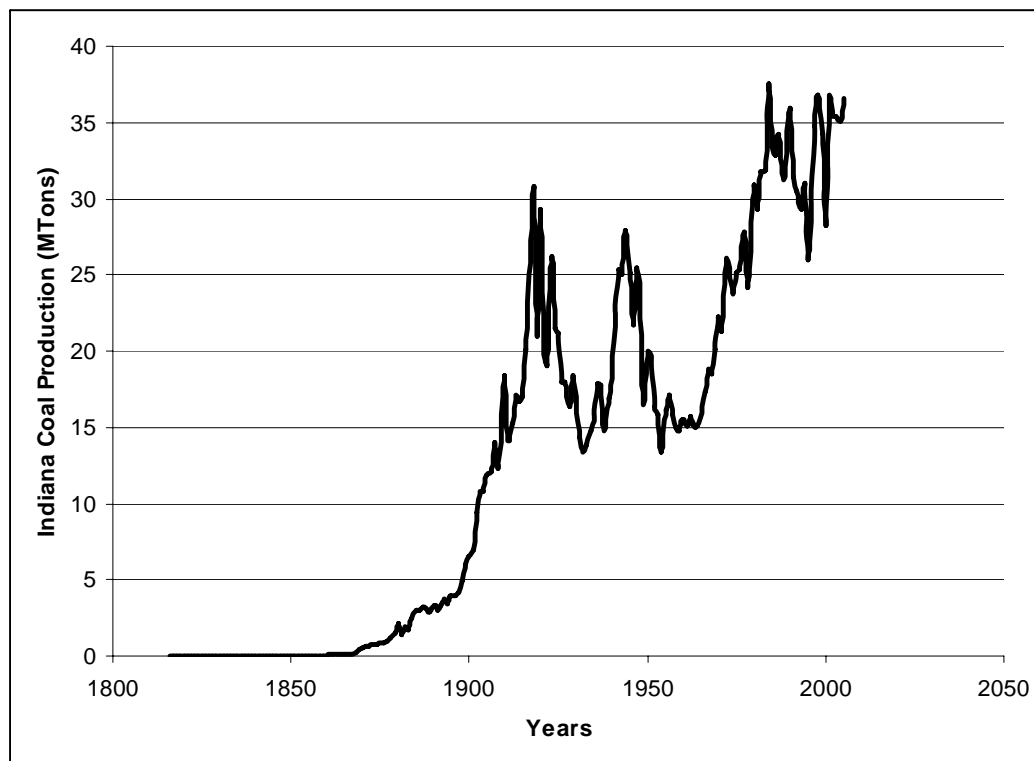
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COAL IN INDIANA

- Indiana has been, is, and will be a state whose energy production and consumption is dominated by coal.
- Has been:

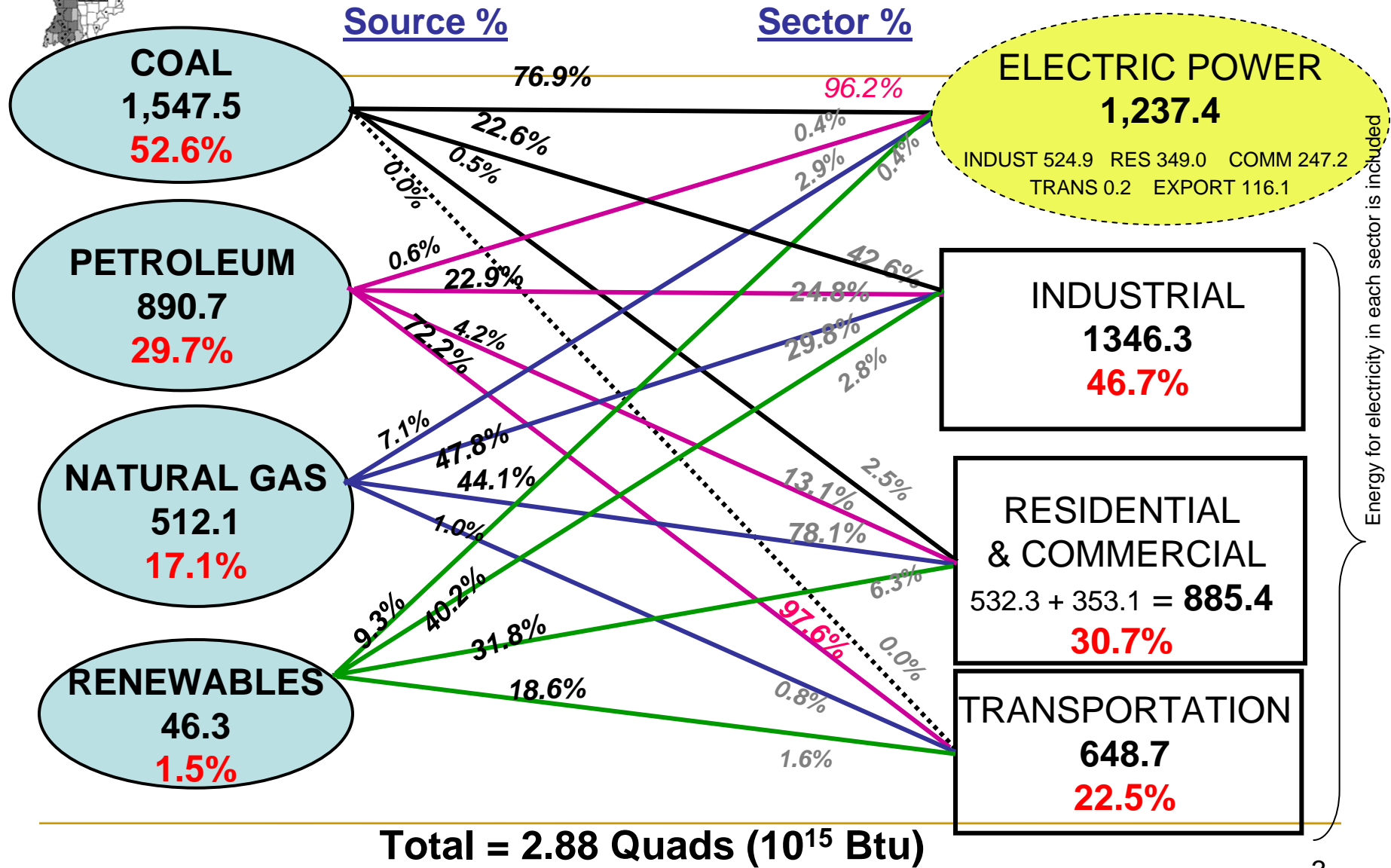
Indiana Historic Coal Production Data



Source: Indiana Coal Report 2006; Figure 3.6.

Indiana Primary Energy Consumption, Source & Sector, 2002

(Trillion Btu, 10^{12} Btu)



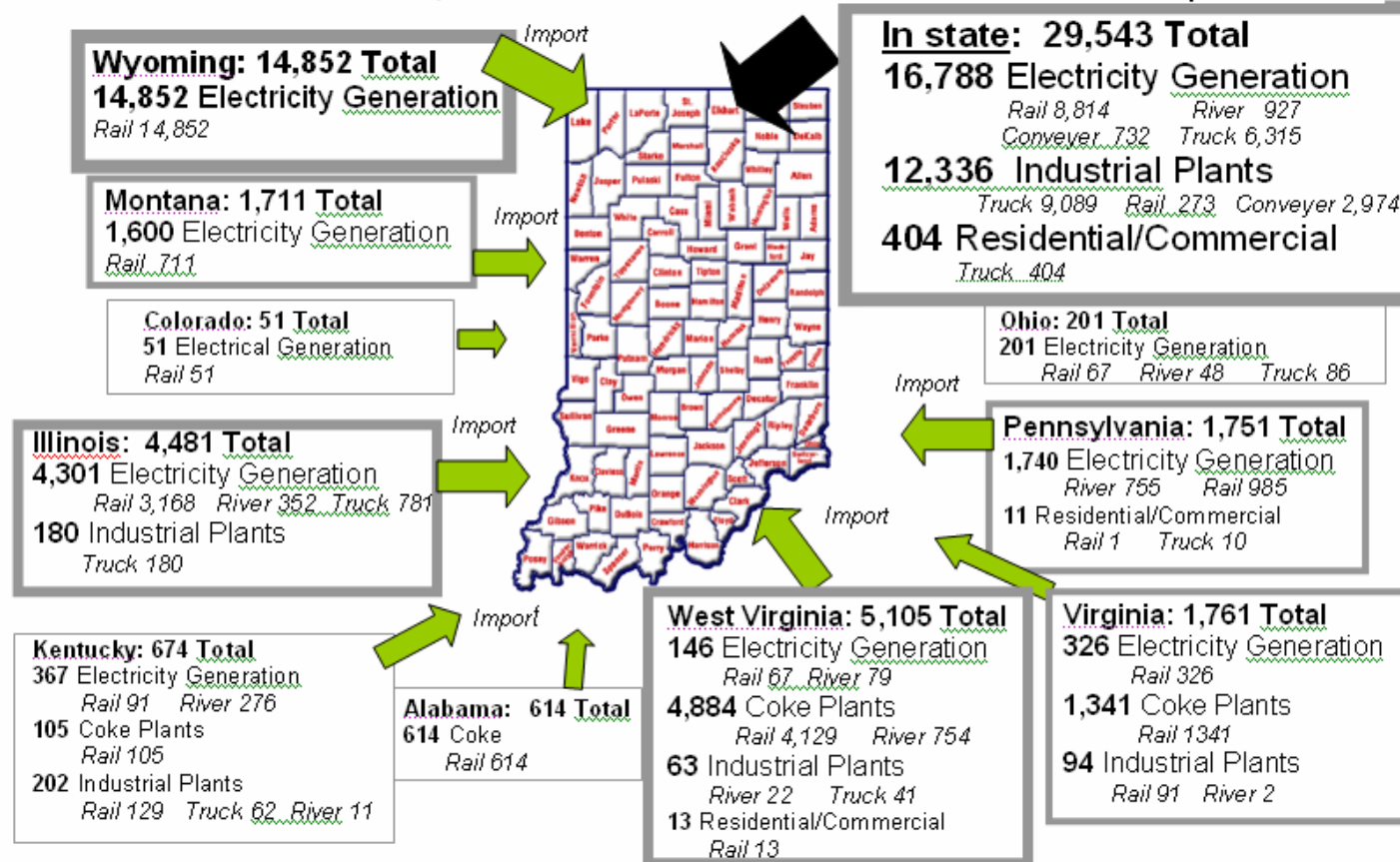
Net inter-state flow of electricity/losses = -116.1



COAL'S CURRENT SOURCES

Coal by Destination State in 2004 - Indiana

State Total of 60,744 Thousand short tons & Methods of Transportation



Source: http://www.eia.doe.gov/cneaf/coal/page/coaldistrib/d_in.html

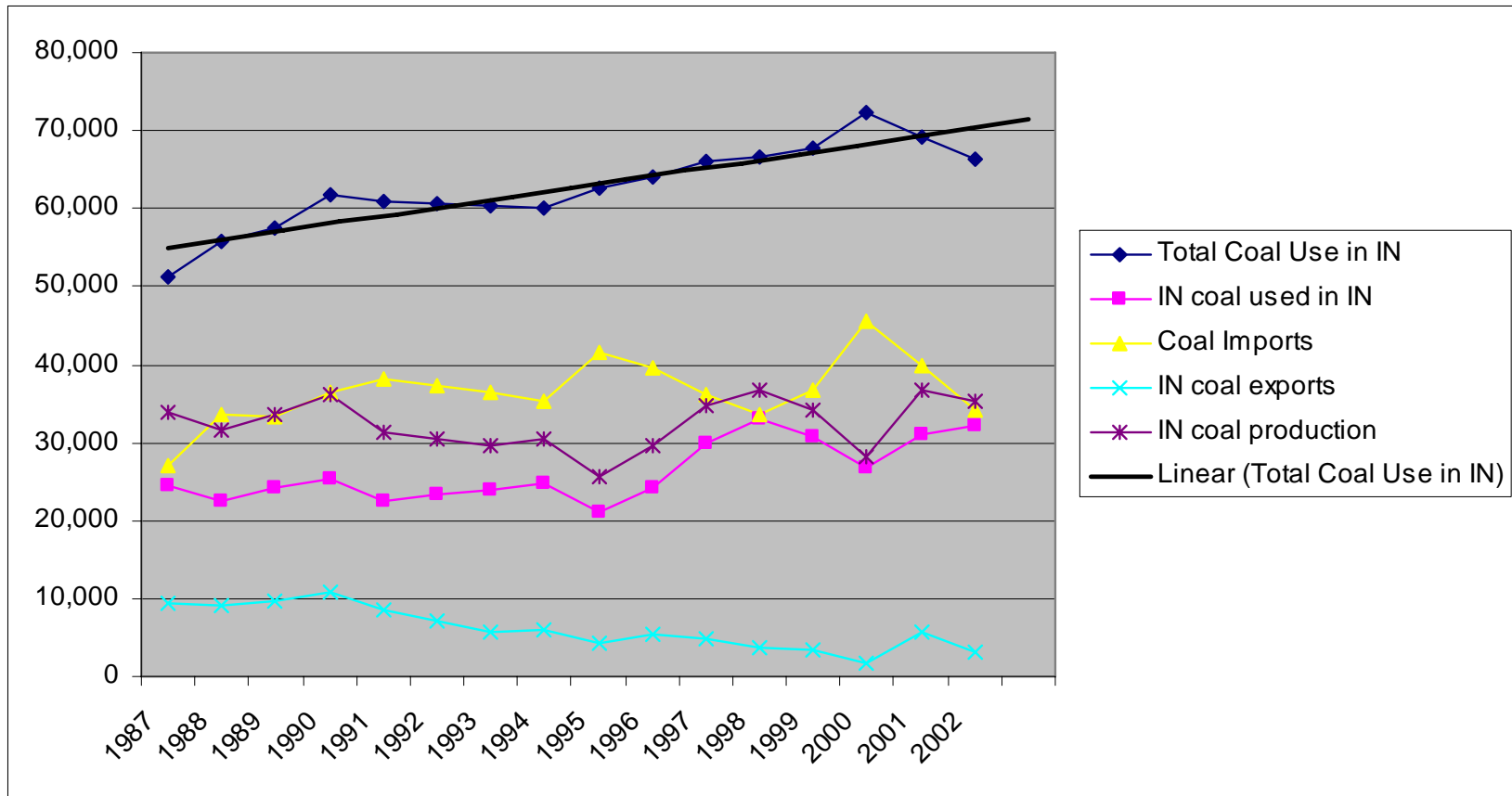
State Totals: **40,481 Electricity Generation**
6,944 Coke Plants, 12,875 Industrial Plants
429 Residential/Commercial

Source: Indiana Coal Report 2006; Figure 3.4.



COAL USE TREND

Indiana coal consumption growing much faster than
Indiana coal production





COAL'S CURRENT IMPACT

- Currently, coal directly adds \$750+ million and 2,836 jobs to our Indiana's economy
- This vastly understates coal's contribution to economic development:
 - Coal unlike petroleum or natural gas has its entire economic impact within the states borders.
- Coal is mined, washed, transported, consumed and the waste is recycled / or disposed within the state each phase generating jobs and revenues streams.
- The coal dollar multiplies faster and farther than any other industrial economic activity.
- One ton of coal generated \$59.59* of activity within the state regardless of how the coal is used.
 - (A \$2 billion economic impact and 11,000 total direct and indirect employment)
- Major reduction on SOx & NOx taking place
- Scrubbers & CCT being considered for and implemented.

* Expanding the Utilization of Indiana Coals, page 20



Coal is the Answer to the emissions problem.
Increasing the use of electricity focuses the emissions issue back to the Utility, you rent pollution control when you buy electricity.

Coal Use Grows While Emissions Decline

Coal Used for Electricity Has Tripled
Since 1970 While Emissions Have Been Significantly Improved

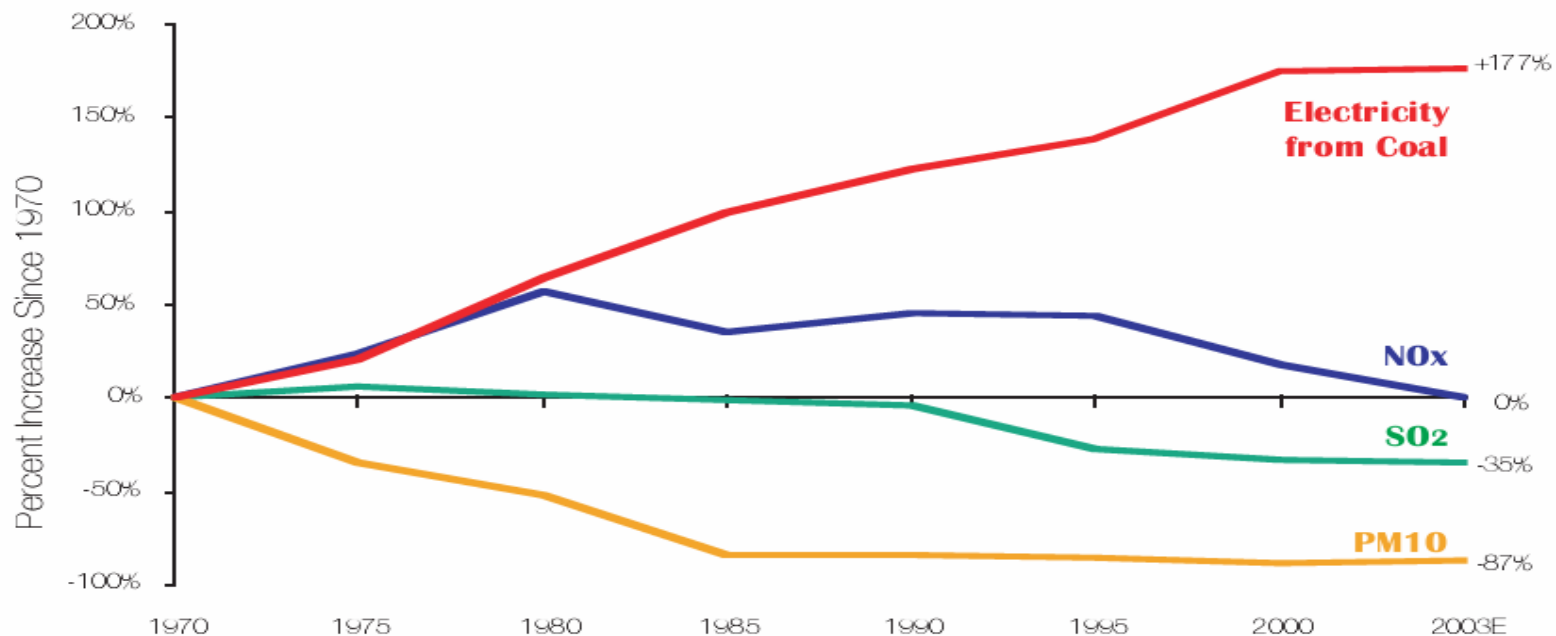


Figure ES.2 Source: EPA National Air Pollutant Emission Trends Dec 2004; EIA Annual Energy Review 2003 (September 2004)

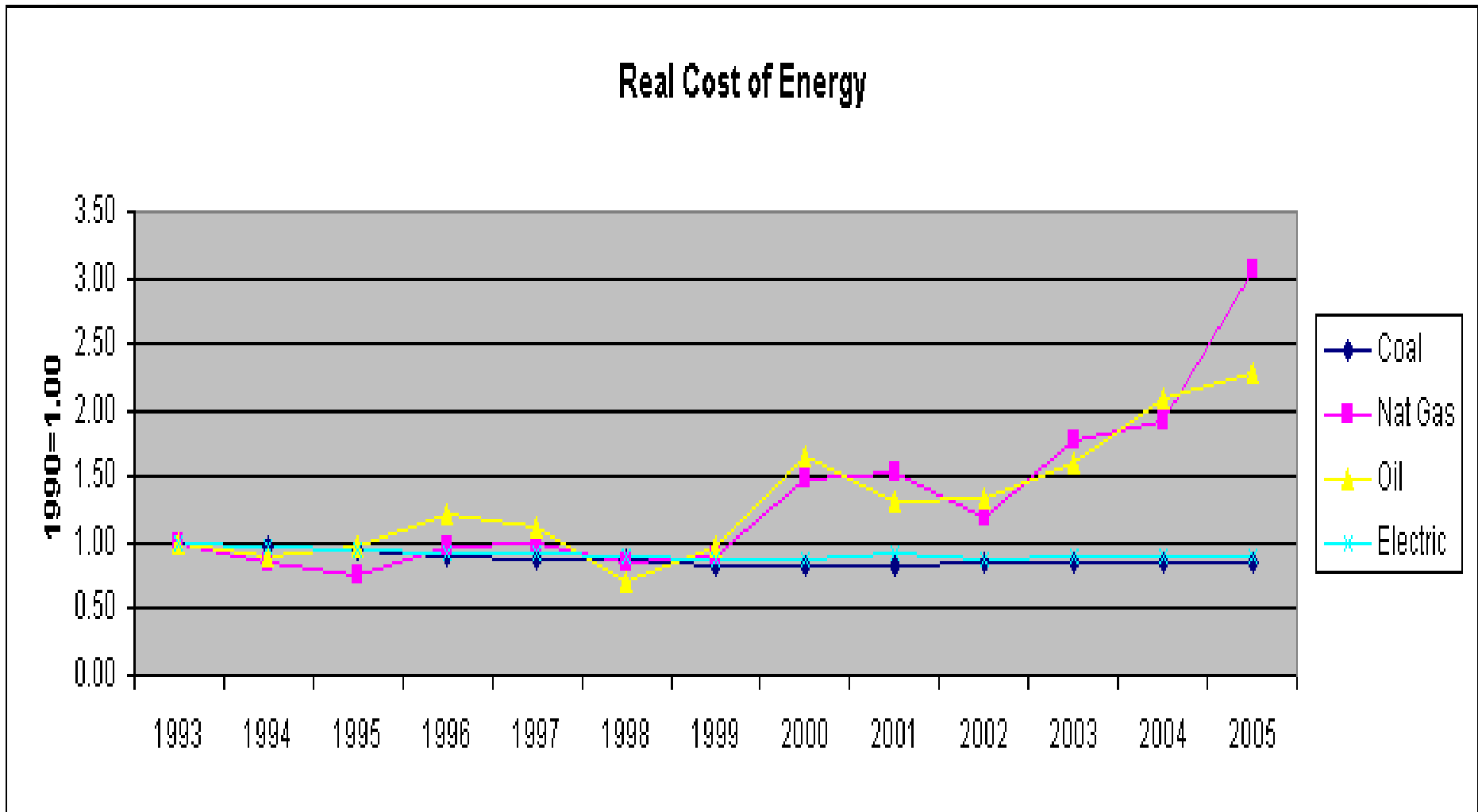


Coal prices are relatively stable in real terms while other forms continue to rise.

In Indiana coal = electricity

Low energy price helps the economy of the state.

If we have a least cost option, use it.





Here we go again....

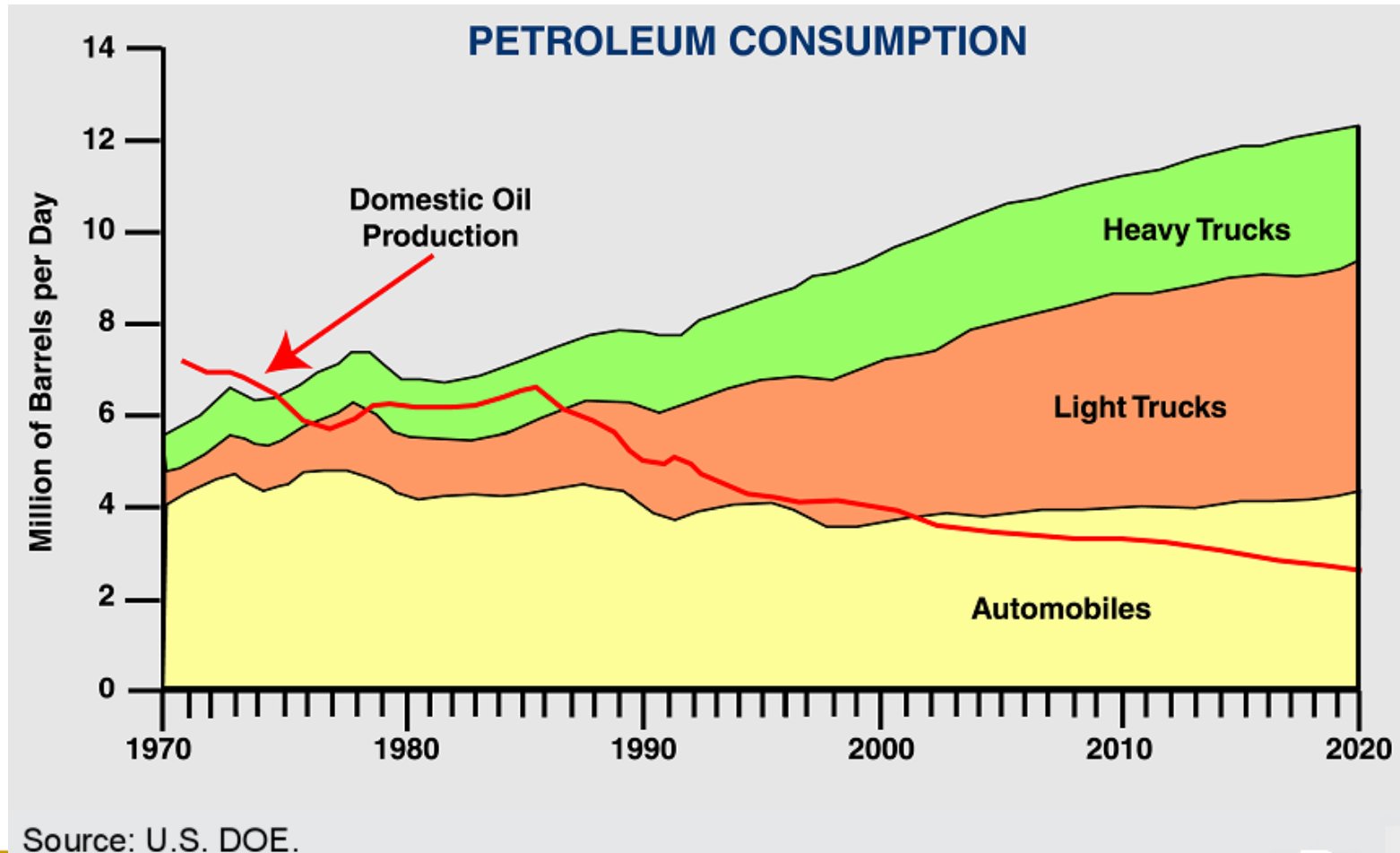
“In 1980, Congress passed the Energy Security Act that created the Synthetic Fuels Corporation, another Carter proposal. Congress authorized \$20 billion in subsidies to promote the production of synthetic fuels from coal, tar sands, and shale oil reserves by private industry in an effort to reduce America's dependence on foreign oil. A single synthetic fuels plant was built at a cost of \$2.1 billion. In spite of these large expenditures, the Synthetic Fuels Corporation did not successfully produce an alternative fuel and never became a profitable venture. After seven years of failed efforts, President Reagan dissolved the corporation.”

Source: National Environmental Trust, Failure of American Policies to Achieve Energy Independence,
<http://www.net.org/proactive/newsroom/release.vtml?id=27583>



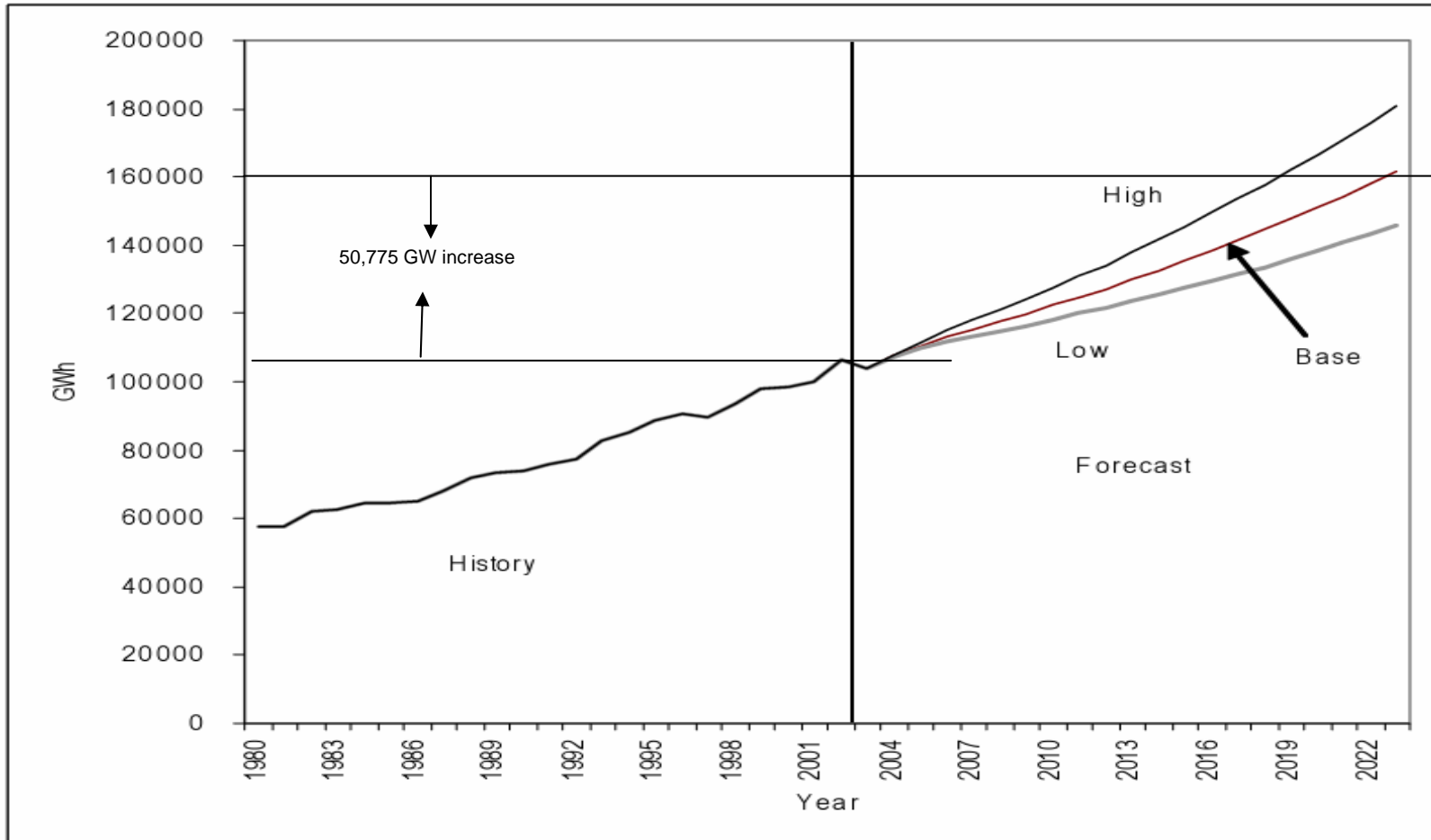
Why again?

U.S. Dependence on Energy Imports





Indiana electric requirement by scenario 45.9% increase in electric demand in next 17 years SUGF





WHAT ABOUT THE FUTURE?

- Import Substitution
- Increase Coal Exports
- Increase “coal by wire”
- All these solutions affected by likely CO₂ legislation, other coal use environmental challenges, if we assume the status quo will persist.
- So: What to do?
Enter CCTR: objective to “increase use of Indiana coal in an economically and environmentally sound manner”



INDIANA'S STRATEGIC ENERGY PLAN

Economic Growth From Hoosier Homegrown Energy



Indiana's Strategic Energy Plan



energy.IN.gov

2006



THE STATE STRATEGY

VISION

Grow Indiana jobs and incomes by producing more of the energy we need from our own natural resources while encouraging conservation and energy efficiency.



THE STATE STRATEGY

GOALS



TRADE CURRENT ENERGY IMPORTS FOR FUTURE INDIANA ECONOMIC GROWTH

- Importing energy exports growth potential
- New plants bring new jobs
- Reduce energy dependency and increase reliability



PRODUCE ELECTRICITY, NATURAL GAS AND TRANSPORTATION FUELS FROM CLEAN COAL AND BIOENERGY

- Build needed new power plants using 'clean coal' technology
- Make gas from coal versus importing natural gas
- Unlock biomass and build on biofuels success



IMPROVING ENERGY EFFICIENCY AND INFRASTRUCTURE

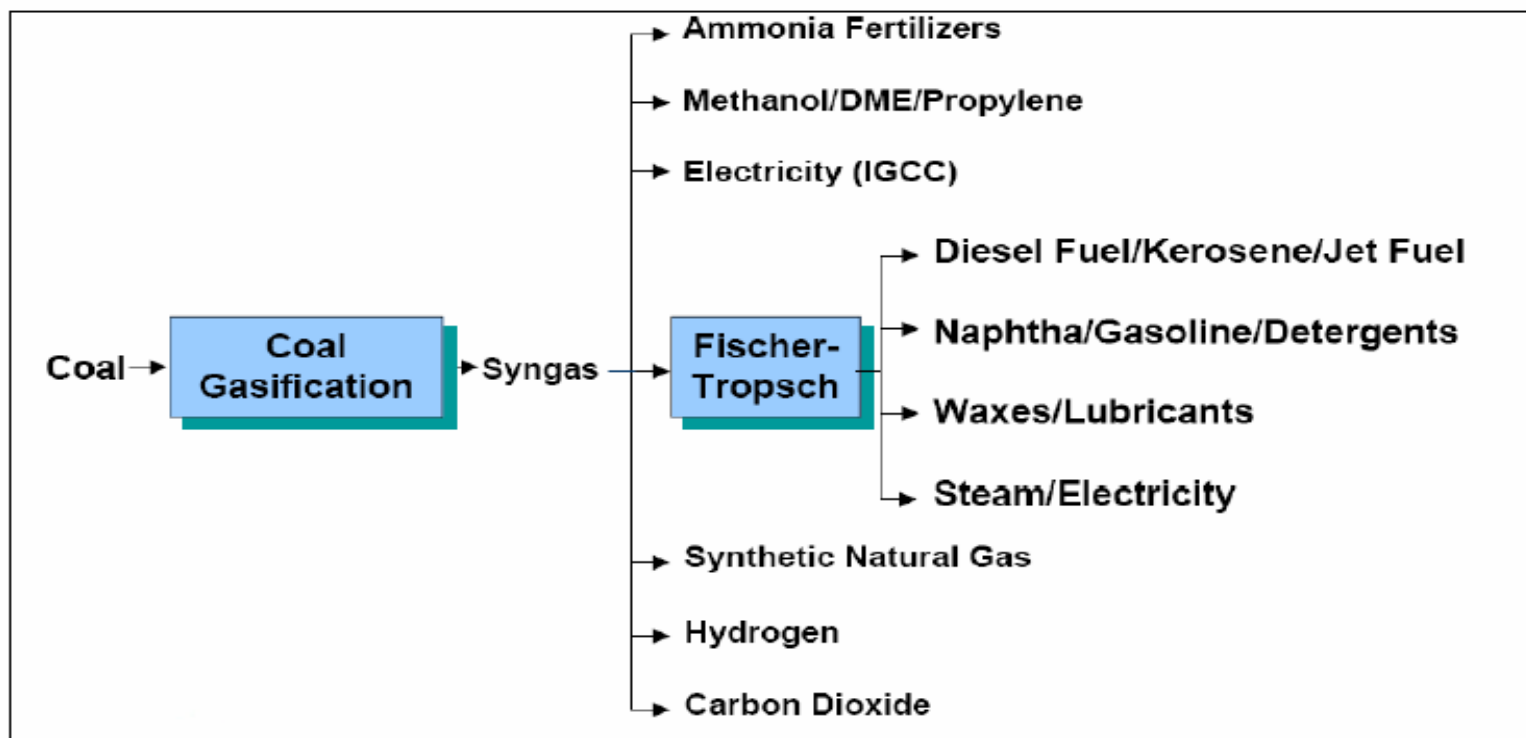
- Create new tools and incentives
- Support flex-fuel fleets
- Strengthen/expand energy infrastructure (including rail)



How to Get There?

Convert Coal to a Usable Resource

Potential Coal-Derived Products



Source: GTI Gasification Symposium, December 2, 2004

http://www.gastechnology.org/webroot/downloads/en/1ResearchCap/1_8GasificationandGasProcessing/LepinskiSmall.pdf



From the gasification basics several products are available to be made.

- The basic process described above requires varying amounts of hydrogen. CH₄ is methane and is the basic product of coal gasification.
- To this you add Oxygen and the result is syngas: **2H₂ + CO**.
- Syngas is the building block for coal based alternate energy production.
- The Syngas can yield different products by adding Hydrogen and CO.

This is the N, in **(2n+1)H₂+nCO yields C_nH_{2n+2} + nH₂O**

- Changing the value of N changes the end product:

Chemical	Product	N value	H/C ratio	Extra H ₂
CH₄	methane	N=1	4.0	
C ₃ H ₈	propane	N=3	2.67	2H ₂
C ₈ H ₁₈	gasoline	N=8	2.25	7H ₂
C ₁₆ H ₃₄	diesel fuel	N=16	1.89	15H ₂

- The further one processes Syngas the lower the H/C ratio.
- More H₂ available for other processes
- We are already well along in the Hydrogen economy:

Wood Peat Coal Petro Natural Gas Syngas Nuclear



KEY COAL ELEMENTS IN THE PLAN

- Common denominator of all thrusts is coal to syngas- allows less expensive removal of CO₂
- Syngas use to be encouraged includes:
 - IGCC
 - F/T
 - Ammonia to fertilizer
- ✓ Interesting Fact: 1 ton of coal would generate \$125 revenue if converted to electricity, \$180 if converted into transportation fuel, with a lower capital investment!
- ✓ Interesting Question: Then how come we're not up to our necks in Coal to Liquid plants?
 - \$3.9 billion and 5 years, (60,000 bpd) if you already have the land permitted and zoned for major industrials.



WHAT NEEDS TO BE DONE IN INDIANA?

- Plan spells out state incentives-tax credits, loan guarantees, speed up permitting to non-utility users.
- Take advantage of fact we still regulate utilities.
- Focus on the permit process, reducing the permitting process for co-generation and self generation is as valuable as the limited cash outlay the State has to offer.
- Ethanol and soy oil facilities are valuable energy extenders and octane enhancers and most importantly are new markets for Indiana agriculture
 - they are also very energy intensive to produce, can best be produced using coal as the low cost energy feedstock.
- 19 measures in all spelled out for state.



What can one ton of coal do? Coal, a resource not a problem

- It can be used to generate 2100 kwh of electricity, which if sold at 6 cents/kwh, would add \$126 to the state's economy
- It can be used to produce 63 gallons of diesel fuel, which, if sold at 2.60/gallon would add \$165 to the state's economy- a 30% increase
- Further, the synfuel route appears to require 30% less capital investment than Pulverized Coal + FGD +SCR+ CO2 capture.



Southwest Indiana Aims to be Home to Large Natural Gas Plant, October 27, 2006

PRESS RELEASE: Evansville, Indiana.

Governor Mitch Daniels today announced there are plans to build a \$1.5 Billion coal gasification plant that would be the first in the country to make pipeline quality natural gas from coal beginning in 2008. The project will include a methanation process to produce pipeline quality substitute natural gas (SNG), which has an identical molecular structure to that of natural gas. It would produce 40 Billion cubic feet of pipeline quality SNG annually, which is enough to supply 15% to 20% of Indiana's residential and commercial gas demand. Its use is projected to save consumers more than \$3.7 Billion over the next 30 years versus the price of conventional natural gas.



So: what is the state doing to encourage the use of coal as a feedstock for transportation fuels?

- **CCTR - The Indiana Center for Technology Research: created by S.B. 29 in 2003 to “encourage the use of Indiana coal in a economically and environmentally sound manner”**
 - **CTL - The Coal Transformation Laboratory in Purdue’s Energy Center created in 2005 to “develop technologies for converting coal into combustible gases and liquids”**
 - **CFA - The Coal Fuel Alliance created in August 2005 to further the objectives of the Obama / Lugar amendment to the 2005 Energy bill, aimed at increasing the use of Illinois basin coals as feedstock for transportation fuels**
-



CCTR Programs

- **General coal studies: IGCC, coal fines use, coal characterization, coke studies, coal transportation mercury control through advanced coal cleaning**

Coal to liquid studies

I. On-Going:

- **4 scoping studies: F/T production, use, environmental impact, policy**
- **Contribution to Lugar / Purdue Summit**

II. Proposed: F/T Production & use

It is OK to put all of your eggs in one basket, just don't ever take your eyes off of the basket.

J.P. Morgan

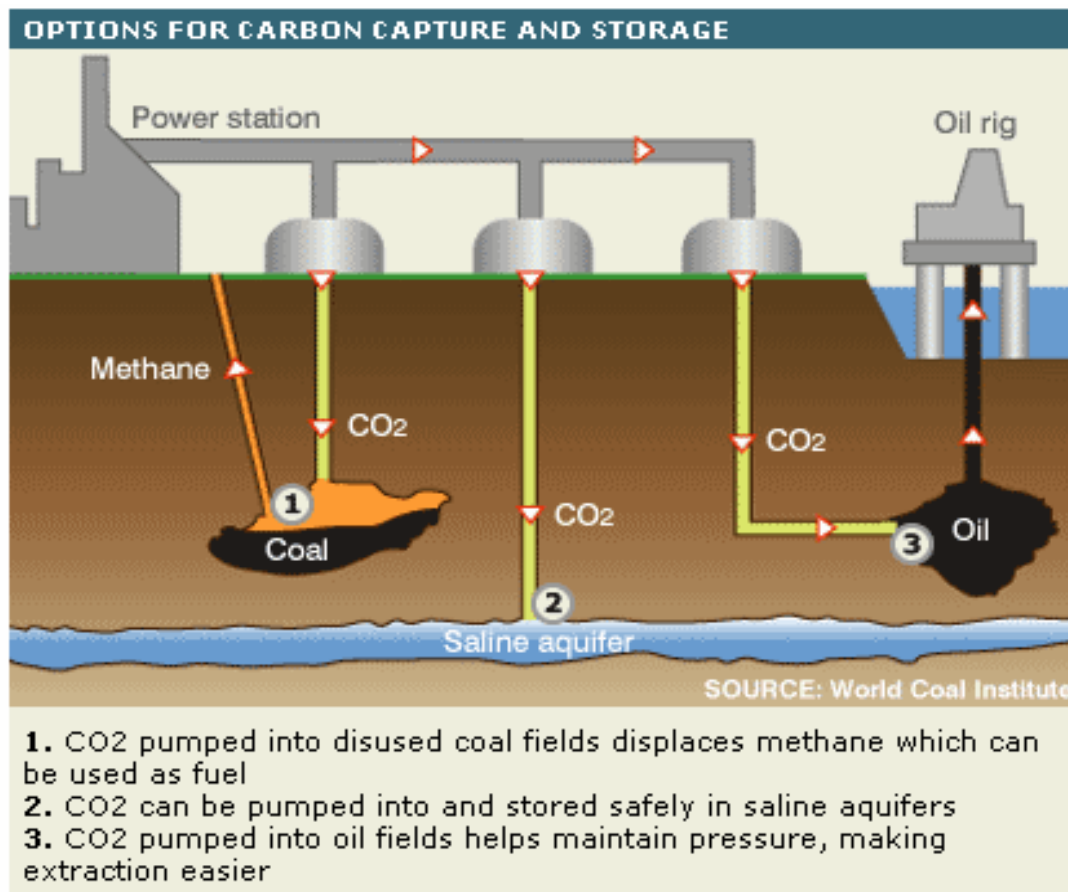


CO2 The Huge Challenge

CO2 Capture & Sequestration

Is there something better?

Yes
CO2
Reuse.
CBM.
New Albany Shale
to Methane.





What are the challenges that must be overcome before coal to liquids becomes a reality?

- 1. Uncertainty regarding crude oil prices-
oil at \$70, make a bundle:
oil at \$40 loose your shirt.**
- 2. Reducing the cost of conversion process: some uncertainty remains.**
- 3. Global warming: coal releases more CO₂ than other fuels.
CO₂ injection? CO₂ conversion?**
- 4. Why not focus on renewables, not coal, for synfuel?**
- 5. Usage in engines-who will certify fuels?**



CONCLUSION

- Now is a very good time to be producing coal in Indiana, and considering expanding corporate presence in Indiana
- Coal is the answer to the energy and environmental issues, not the problem.
- Energy Ranch, SynFuel Park, We have the pieces:
Edwardsport, Wabash, Edwardsport, Indiana Gasification, LLC,
Coal mines, New Albany Shale, Geological structure,
natural gas pipelines and the electric grid system;
Indiana is close to the goals of \$1 billion DOE FutureGen project,
and we did not submit a proposal.



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- We welcome visits. Please contact:

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