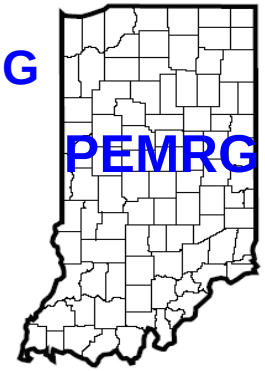
PURDUE ENERGY MODELING
RESEARCH GROUPS



Factors that Affect the Design & Implementation of Clean Coal Technologies in Indiana: Phase 2 – Feasibility Studies

Presentation to the

CCTR Advisory Group

by

Ronald L. Rardin, Principal Investigator and

Zuwei Yu, Senior Analyst

Purdue Energy Modeling Research Groups (PEMRG)

Phase 1 – Scoping Study

(completed December 2005)

PURDUE ENERGY MODELING RESEARCH GROUPS

PEMRG

Phase 1 Project Team

PURDUE:

- Ronald L Rardin, PI
- Zuwei Yu, CoPI
- Forrest Holland, CoPI
- Tony Black, GRA
- Jesse Oberbeck, GRA

(with help from other SUFG staff)

ADVISORS:

- Dick Foltz (& Gayle Mayo), IMPA
- Allen McKee, WVPA
- John Rupp (& Maria Mastalerz), IGS
- Francois Botha, ICCI
- Bill Simmons, Coalteck

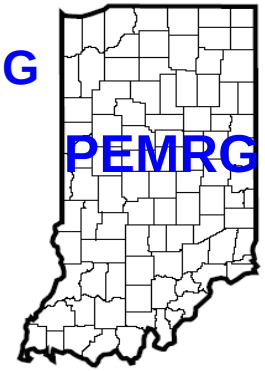
(with guidance from Cinergy)

Clean Coal Technology (CCT)

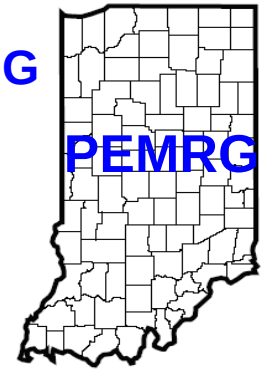
- CCT $\approx$ methods for using coal with substantially reduced environmental emissions
- Includes Integrated Gasification Combined Cycle (IGCC) with near zero emissions
- What coal-fired & combinations to include?
  - Supercritical PC (high temp & pressure)
  - Circulating Fluidized Bed (input with limestone)

Phase 1 Effort

- Study began by developing a compendium of information about topics along two dimensions
  - First is the technologies of CCT
  - Second is the Indiana environment for CCT
- Then investigated a series of scenarios about alternative technologies, and CO_2 capture (or not) in new construction and/or some retrofit, in order to address CO_2 possible regulation

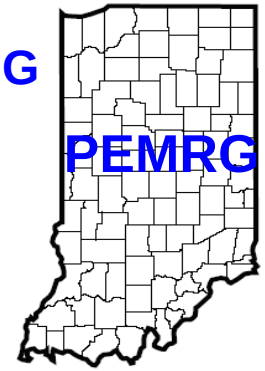


Phase 2 – Feasibility Studies of Some Indiana Project Concepts



Phase 2 - Vision

- Develop and refine concepts for two related categories of Indiana CCT projects
  - Coal by Wire (clean coal merchant plants)
  - More ambitious Synfuel Park producing power, liquid fuels, fertilizers, steel coke, etc
- Investigate for each the likely technologies, financing, markets, location, fuel sources, costs, and management of CO_2 & other environmental concerns



Phase 2 - Purpose

- Assess the feasibility of CCT projects that could
  - Promote the environmentally responsible use of Indiana coals
  - Stimulate economic development within the state
- Continue building research/analysis capacity to deal with future CCT and regulatory issues

Coal by Wire - Location

- Siting
  - Mine-mouth or other
  - Water requirements
  - Access/transport for coal supplies
  - Access/location for CO_2 management
- Transmission network
  - Current system loading
  - Need and cost of expansion or new construction

Coal by Wire - Technologies

- Power Production Technologies
  - Integrated Gasification Combined Cycle (IGCC)
  - Atmospheric Fluidized Bed Combustion (AFBC)
  - Super/Ultra Critical Pulverized Coal (SCPC)
- Opportunities for biomass co-firing
- Emission Prevention/Regulation
  - SOx, NOx, Mercury

Coal by Wire - CO_2

- Capture technologies
- Disposal/sequestration technologies
- Economic issues
  - Sequestration/transport costs
  - Stimulation of valuable products (e.g. coal bed methane)

Coal by Wire - Financing

- Capital & operating costs
- Potential markets for electricity produced
  - Where to sell
  - Likely prices (baseload vs. cycling)
  - Reliability credits (e.g. MISO)
- Potential investors
- Impacts of federal, State and/or local incentives
  - Loan guarantee (e.g. DOE) impact on capital cost
  - Tax incentives
  - Future inclusion in the State rate base

Coal by Wire – Econ Impact

- Assessment of macro-economic impacts of the proposed Coal by Wire project
  - Use of Indiana coal
  - Jobs & economic activity from construction & operation

Synfuel Park - Location

- All the same location issues as the Coal by Wire
- Added considerations of access to markets for non-power products (synfuels, chemicals, etc.)
- Added land requirements, transportation & connectivity interactions among operations

Synfuel Park - Technologies

- Direct Coal Liquification (DCL)
  - Status/costs of technologies
  - Fuel produced (gasoline, diesel, methanol, etc.)
- Indirect/Gasifier Coal Liquification (ICL)
  - Status/cost of technologies
  - Fuel produced (gasoline, diesel, methanol, etc.)
  - Conflicts & synergies with power production (polygeneration, peak vs. offpeak)
- Direct sales of syngas
- Steel coke manufacture (sister project)

Synfuel Park – CO_2

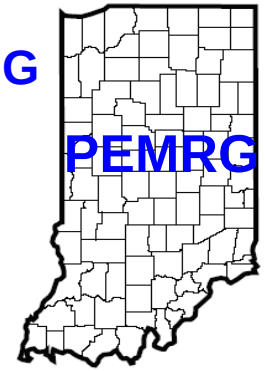
- Same removal and sequestration/management issues as with the Coal by Wire, including potential for economic value
- Additional options/technologies in various liquid fuel technologies
  - Different CO_2 concentrations, different stages
- Potential link to an Indiana role in FutureGen

Synfuel Park - Financing

- Same electricity considerations as Coal by Wire
- Many additional technologies for which to estimate capital & operating costs
- New concerns for markets of other products
- New opportunities to spread capital costs & incentives across related industries & draw wider range of investors (e.g. venture capitalists)
- New options for federal/State/local site incentives (such as Ports of Indiana)

Synfuel Park – Econ Impact

- Use of Indiana coals still central
- Now potentially wide array of industries contributing jobs & economic development
  - More complicated assessment



Task A – Data Collection

- Refine existing knowledge of CCT costs, technologies & markets
- Investigate potential sites, including potential for CO_2 management
- Investigate liquid fuel, chemical & coke technologies, costs & markets
- Collect information on investment markets & economic impacts of projects

Task B – Min Cost Designs

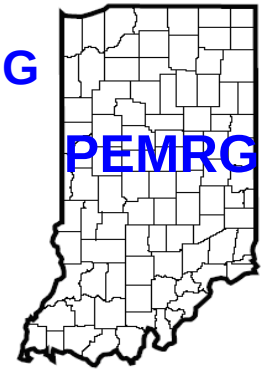
- Conduct modeling to determine least cost designs for Coal by Wire alone
- Elaborate to encompass Synfuel Park
  - preferred mix of technologies
  - costs, markets & financing for each
  - technology synergies & interfaces
- Assess risks due to technology, financing & markets

Task C – Financing & Econ Impact

- Investigate potential sources of financing
- Delineate and analyze options for federal, State and/or local incentives
  - Impacts on financial viability of projects
  - Costs to Indiana rate/tax payers
  - Conduct modeling to develop preferred alternatives
- Develop estimates of job & development impacts
  - Use of Indiana coals
  - Construction
  - Long term (coal & other)

Deliverables

- Progress reports at Advisory Group meetings
- Final report
  - Reviewing data and analysis
  - Assessing the feasibility of the Coal by Wire and Synfuel Park projects
  - Suggesting preferred alternatives
  - Outlining needs for further research



Phase 2 – Time & Budget

- Twelve months from approval and notice to proceed for this phase
- Total budget of $150K from CCTR
- Quarterly updates at Advisory Group meetings
- Final report at end of project period

(Hope to have cooperation and advice from partners at IGS, Cinergy and elsewhere)