Factors That Affect the Design of Clean Coal Technologies – Phase II: Final Report

Synfuel Park Location Study

by
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Phase 2 Project Team

PURDUE:

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Phase 2 Project Team (cont'd.)

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- John A. Rupp
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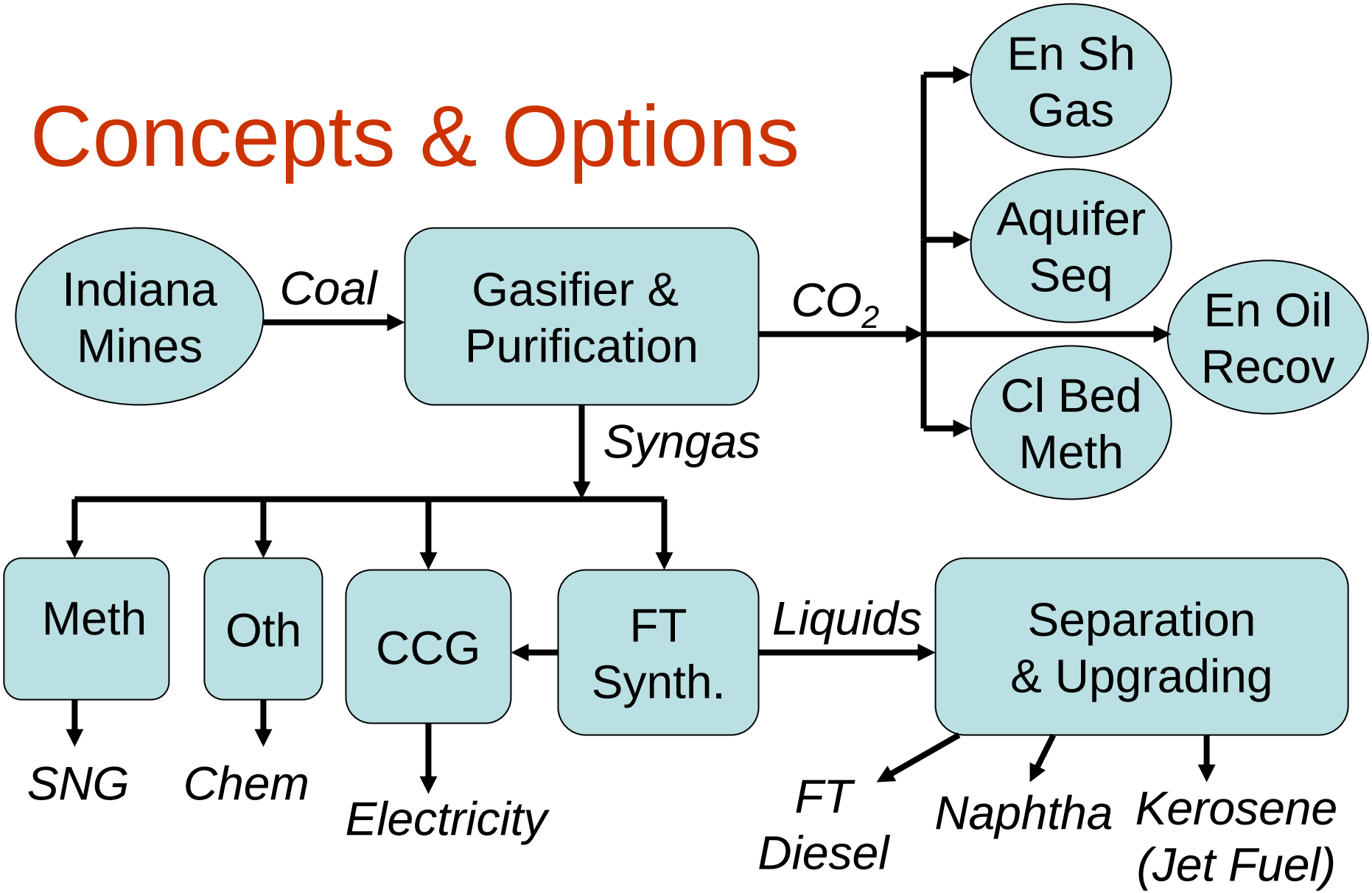
- Plus numerous others providing advice and information in support of the project including:

- Mr. Rich Cooper, Director, Port of Indiana
- Mr. Kent Curry, Director of Regulatory Affair, AEP
- Mr. Daren Eliason, Dakota Gasification Company
- Mr. Kent Holcomb, the Francisco Mine, Indiana
- Mr. Renus Kelfkens, Sasol North America
- Dr. Thomas Lynch, Chief Engineer, Wabash IGCC Plant
- Mr. Mark Newlin, General Manager of Regulatory Affair, Duke Energy Indiana
- Mr. Mike Rampley, Sr. Vice President, Hoosier Energy
- Dr. Mike Reed, System Analyst, NETL/DOE
- Mr. Mark Sabree, Business Manager, the Black Beauty Mine, Peabody, Indiana
- Mr. Phil Wilzbacher, Director, Port of Indiana Mount Vernon
- and many others too numerous to list.

Phase II Vision

- Investigate the feasibility of one or more Synfuel Parks in the state using gasified Indiana coal to produce
  - Any or all of Fischer-Tropsch (FT) Diesel, Jet Fuel, Electricity, Synthetic Natural Gas, and related chemicals
- Having conforming air & water emissions and expectation of sequestering CO_2

Concepts & Options



Site Selection Criteria

- Coal access
- Sequestration access
- Land availability
- Transportation (rail, highway, water way)
- Transmission lines
- Gas pipelines
- Water availability
- Waste disposal, environment
- Labor force
- Economic development

Specific Sites Evaluated

- Breed/Fairbanks
- Crane – Glendora (near Sullivan)
- Crane (Main)
- Merom
- Minnehaha
- Francisco
- Mt. Vernon (CountryMark and Port of IN)

Site Locations

States and Provinces
Counties
Oceans
Electric Substations

Electric Transmission Lines
Voltage Class kV

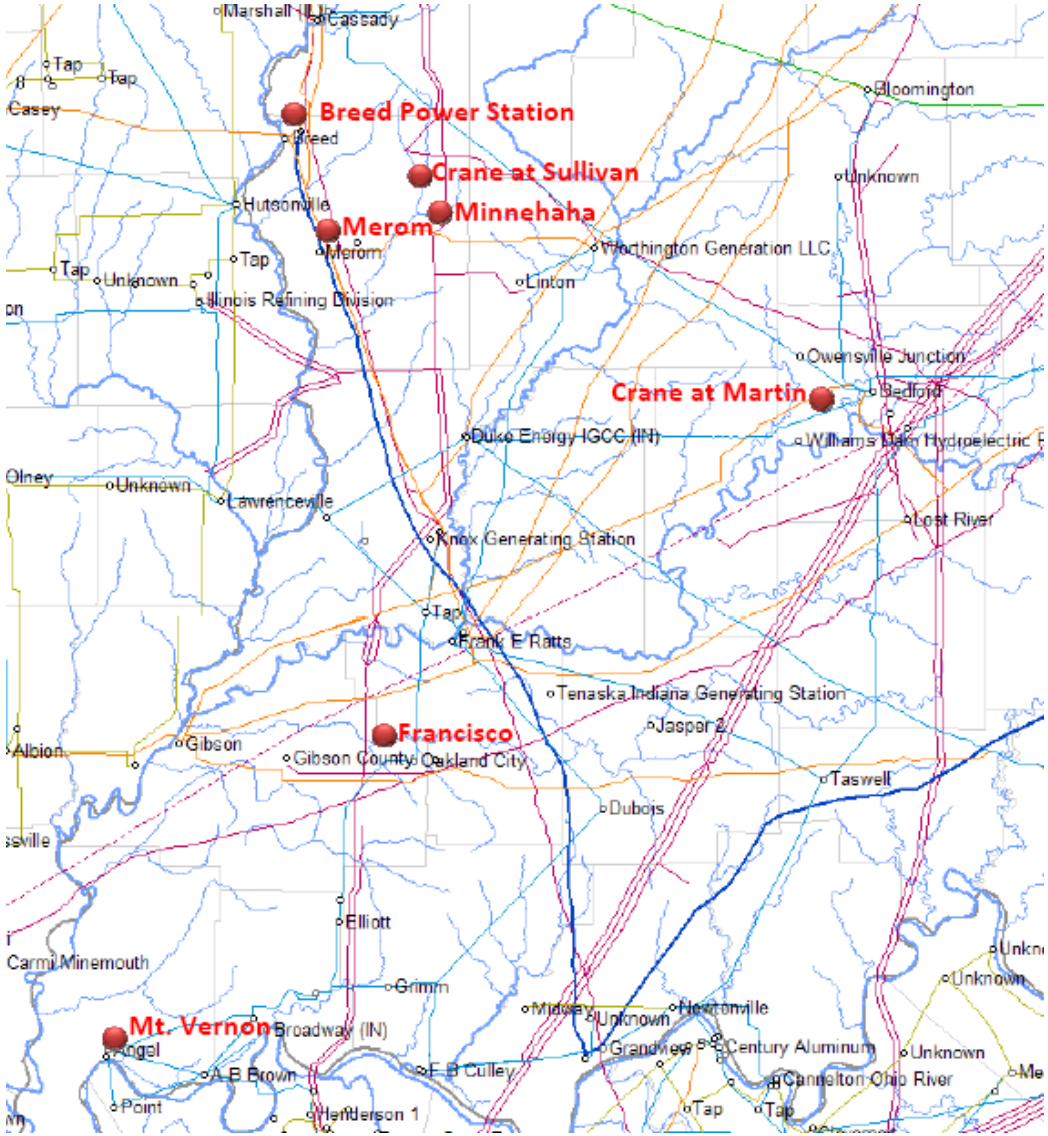
Under 100
100-161
230-287
345
500
735 and Above
DC Line

Natural Gas Pipelines
Status

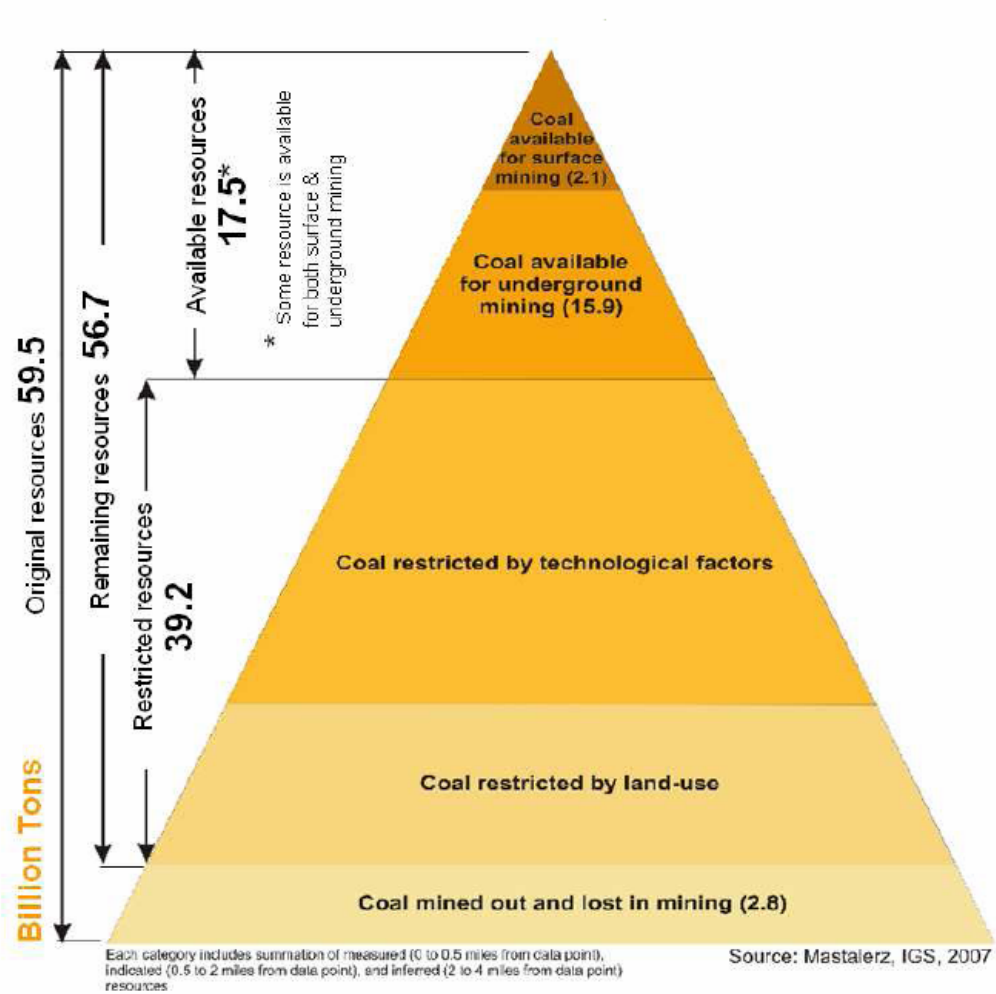
In Service
Proposed

Rivers
By Type

Rivers
Streams/Tributaries



Coal Availability



Potential Sequestration Access

- Generally good opportunities in southwest Indiana
  - Saline aquifers
  - Enhanced coal bed methane (ECBM)
  - Enhanced oil recovery (EOR)
  - Enhanced shale gas (ESG)
- Details vary by site
- Centralized sequestration for multiple sites may be desirable

Land Availability

- Land required for a 10,000 b/d plant
  - About 120 acres for the plant, including water cooling and treatment
  - About 20 acres for coal handling
  - About 500-1,000 acres for slag/ash disposal
  - Total: 640-1,140 acres for 10,000 bbl/d
- There may be some economies of scale in land requirements, especially for large ops.

Supporting Infrastructure

- Transportation (rail, highway, waterway)
  - Construction phase (transport of large equipment)
  - Operation phase (coal in/products out)
- Transmission lines (in for construction/out for power export)
- Gas pipelines (in for construction/out for SNG)

Supporting Infrastructure

States and Provinces
Counties
Oceans
Electric Substations

Electric Transmission Lines
Voltage Class kV

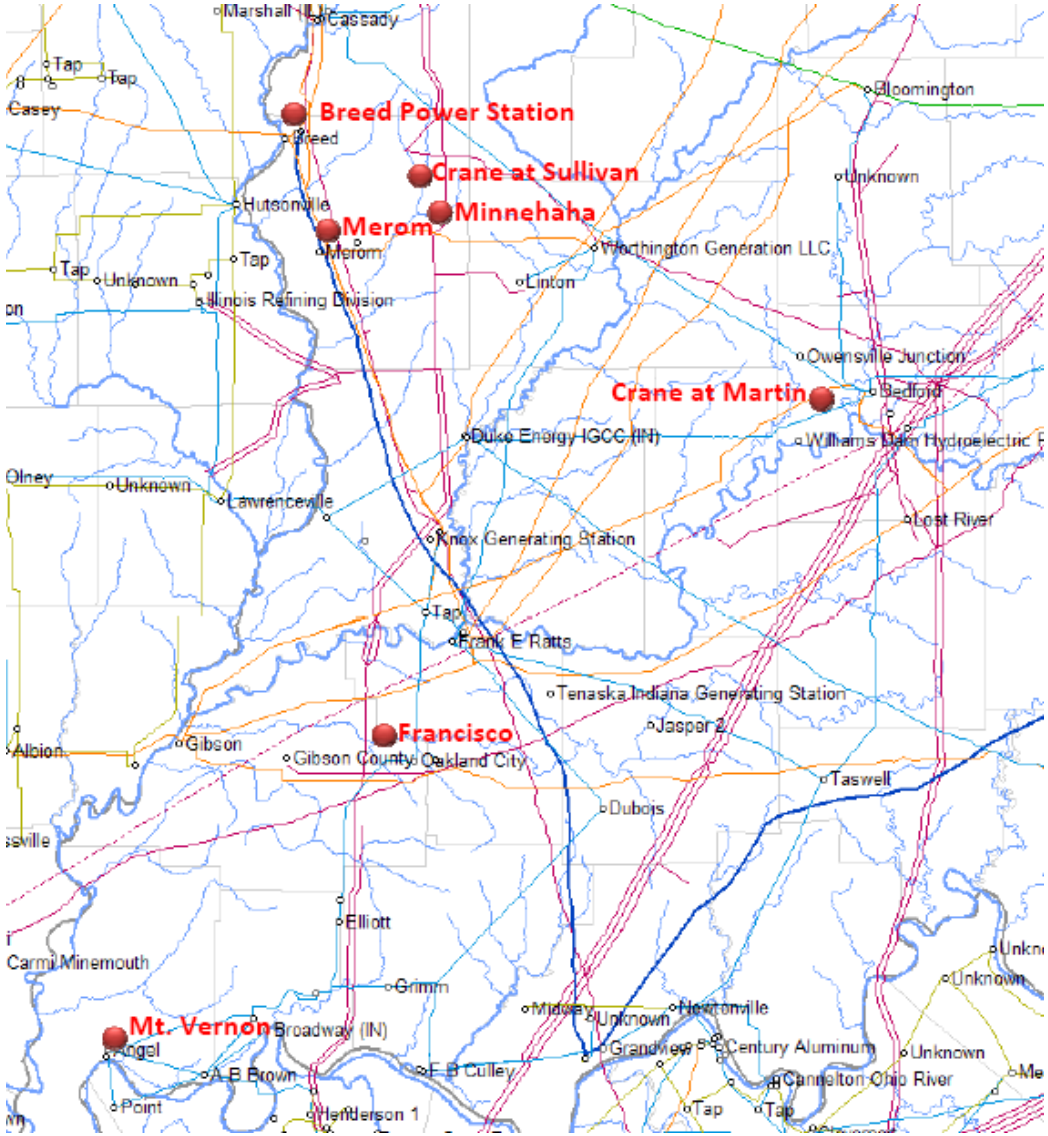
- Under 100
- 100-161
- 230-287
- 345
- 500
- 735 and Above
- DC Line

Natural Gas Pipelines
Status

- In Service
- Proposed

Rivers
By Type

- Rivers
- Streams/Tributaries



Water Needs

- Water requirements can be substantial
  - Roughly 15 bbl water/bbl FT liquids
  - 10,000 bbl/d = 150,000 bbl/d
- Use of air cooling or hybrid systems can substantially reduce these requirements
- There are economies of scale in water use

Waste Disposal/Environment

- Synfuel plants with CO_2 sequestration relatively benign environmentally
  - Waste water can be treated to remove pollutants
  - Air emissions (based on IGCC experience) superior to pulverized coal power plants
  - Solid wastes (slag and ash) inert and may be useful as construction materials

Labor Force

- NETL estimates 144 direct operations people for 50,000 bbl/d
- Administrative and support personnel likely add another 40-50 percent
- Scaling is probably not linear – smaller scale operations require more labor per bbl

Labor Force (cont'd.)

- Training will be an issue, but resources are available (Purdue, IU, Vincennes, Ivy Tech, ISU)
- Wabash Valley Power Association IGCC

Economic Development

- NETL estimates indicate gross revenues (including exported power) of about $80 per barrel of FT liquids – $750,000 per day even for a small plant (90% capacity factor)

- Indirect impact much larger through multiplier effect

Economic Development (cont'd.)

- Counties surrounding the sites
  - Have higher unemployment than the State average (except Daviess and Dubois)
  - Have lower per capita income than the State average (except Dubois, Posey, Vanderburg and Warrick)
- Need for economic development is substantial – potential contribution is large

Breed/Fairbanks

- Coal available nearby – 10-15 miles
- CO_2 sequestration potential substantial (SA, ESG, ECBM, EOR)
- Land available excellent – brown field site (9,000 acres)
- Infrastructure good – rail&highway access, electricity transmission lines available onsite, oil and gas pipelines close by

Breed/Fairbanks (cont'd.)

- Water resources available from Wabash – a 50,000 bbl/d plant = ~1% of stream flow
- Labor availability – close to Sullivan and Terre Haute
- Potential capacity – 50,000 bbl/d; 300 MW export; SNG possible

Crane – Glendora

- Coal available nearby – 3-10 miles
- CO_2 sequestration potential good (SA, ESG, ECBM, EOR)
- Land available – 750 acres on site (sufficient for FT plant, may not be enough for slag/ash – mined out strip mines nearby)
- Infrastructure is good with nearby access to transmission line, gas and oil pipelines, rail

Crane – Glendora

- Water may be a limiting factor – two lakes available: Glendora and Sullivan
- Labor available – close to Sullivan and Terre Haute
- Potential capacity – 20,000 bbl/d; 100 MW export; SNG not recommended

Crane – Main

- Coal available within 10-30 miles
- CO_2 sequestration potential good (SA, ESG, ECBM, EOR)
- Land available – 63,000 acres on site
- Infrastructure is good with onsite access to transmission line, gas pipeline and rail onsite; nearby access to oil pipeline and road

Crane – Main (cont'd.)

- Water available from East and West Forks of the White River (East Fork is 2 mi from Crane) with adequate stream flow
- Labor available from Crane and communities in surrounding counties
- Potential capacity – 20-30,000 bbl/d; 150 MW export; SNG needs further evaluation

Merom

- Coal available within 10-15 miles
- CO_2 sequestration potential substantial (SA, ESG, ECBM, EOR)
- Land would need to be purchased
- Infrastructure is good with electricity transmission lines and rail onsite; oil and gas pipelines, and roads nearby

Merom (cont'd.)

- Water availability is excellent as this site is located on the Wabash (even a 50,000 bbl/d plant would only take ~1% of stream flow)
- Labor availability is good with Sullivan, Terre Haute and Vincennes nearby
- Potential capacity – 50,000 bbl/d; 300 MW export; SNG possible

Minnehaha

- Coal availability ideal (mine mouth site)
- CO_2 sequestration potential substantial (SA, ESG, ECBM, EOR)
- Land availability – strip mines in the area could be reclaimed
- Infrastructure is good with electricity transmission lines, rail, oil and gas pipelines, and roads nearby

Minnehaha (cont'd.)

- Water availability is limited – Lake Sullivan and Lake Glendora are reasonably close, or water could be piped from the Wabash (11 mi)
- Labor availability is good with proximity to Sullivan, Terre Haute and Vincennes
- Potential capacity – 10-20,000 bbl/d; 50-100 MW export; SNG not recommended

Francisco

- Coal availability ideal (mine mouth site)
- CO_2 sequestration potential excellent (ESG, SA, ECBM, EOR)
- Land availability is excellent: abandoned strip mines and agricultural land nearby
- Infrastructure is good with onsite rail access and electricity transmission lines, oil and gas pipelines, and roads nearby

Francisco (cont'd.)

- Water availability is limited – Patoka River might support 10,000-20,000 bbl/d
- Labor availability is good with proximity to Evansville
- Potential capacity – 20,000 bbl/d; 100 MW export; SNG not recommended

Mt. Vernon (SMC and CM)

- Coal availability is good – 30 miles to mines
- CO_2 sequestration potential excellent (ESG, SA, ECBM, EOR)
- Land availability is good with 150 acres at SMC and farm land available nearby
- Infrastructure is good with onsite access to rail, oil and gas pipelines, and limited electricity transmission capacity, and roads are available nearby

Mt. Vernon (cont'd.)

- Water availability– SMC on Ohio River; CM 1-2 miles from Ohio River
- Labor availability is good with a potential workforce from Mt. Vernon and surrounding communities
- Potential capacity
  - SMC 50-100,000 bbl/d; 3-600 MW export; SNG possible
  - CM 20-30,000 bbl/d; 100-150 MW export; SNG possible

Conclusions for CCT in IN

- There are many reasons to consider siting synfuel parks in Indiana
  - Coal resources available
  - Economic development needed in coal producing areas
  - Contributes to the energy security of the state and nation

Conclusions for CCT in IN (cont'd.)

- Several sites were evaluated and found to be feasible
- No site dominates all others, and not all relevant criteria were evaluated (e.g., ecosystem impacts)
- There will be challenges for every site, and each site has its own advantages

Next Steps for CCT in IN

- Location of plants using Clean Coal Technology for CTL has been the primary focus so far
- Work to date has revealed that Fischer-Tropsch reaction creates challenges
- Future work could consider the full spectrum of uses for gasified coal: CTL, SNG, Methanol, fertilizers, other chemicals, electricity

Next Steps for CCT in IN (cont'd.)

- Need to prioritize development efforts
  - Estimate benefits and costs for alternative types of plants
  - Evaluate alternative sites relative to alternative primary products

Next Steps for CCT in IN (cont'd.)

- Electric power generation is an important part of the equation
  - More capacity needed
  - If re-power/expand based on SNG from CTG, where first?
- Understanding transmission and distribution network expansion needs critical (MISO)

Next Steps for CCT in IN (cont'd.)

- CO_2 will also play a critical role siting
  - Impending site selection for FutureGen
  - Potential for CO_2 legislation