Coal Country Development Initiative

Leveraging local resources for new venture creation

October 2005

Principal Investigators: Trillium Planning & Development, Inc.
Yale University Industrial Environmental Management Program

Assistance provided by: North Dakota Department of Commerce
Mercer County Economic Development

Trillium Planning & Development

October, 31, 2005

John Phillips
Mercer County Economic Development
120 Central Avenue North
Beulah, ND 58523-0910

Dear John,

At your request we are providing this final report of findings for the Coal Country Development Initiative. The report is organized by the primary tasks of the project including:

1. An accounting of the assets and resources of Mercer County (baseline characterization)
2. Benchmarking of projects with similar objectives
3. Assessment of industries that could take advantage of available resources
4. A preliminary business development marketing strategy for capturing some target industries

Data collection and analyses were conducted by Trillium Planning & Development and the Yale University Industrial Environmental Management Program. The principal investigators were Corey Brinkema (Trillium), Woon Kwong Liew (Yale), and Bailey McCallum (Yale). We should take this time to thank you John, as well as Renee Loh and Linda Butts of the Department of Commerce for the considerable guidance and assistance provided during the project.

It has been a pleasure assisting you with your business development effort. Please feel free to contact us regarding any aspect of this document. We look forward to continuing to advance the goals of the Coal Country Development Initiative.

Regards,

Corey Brinkema
Principal

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Table of Contents

List of Figures

1. Background

1.1. Objective

The purpose of the Coal Country Development Initiative is to attract and develop new industry in North Dakota's Coal Country, located northwest of Bismarck and south of Lake Sakakawea. Broadening the industrial base of the area would create jobs and diversify the local economy. In support of the Initiative, this paper defines the potential of Coal Country's material, energy, infrastructure and intellectual assets as levers for new business development. Marketing the region's lignite energy resources as low cost industrial inputs, for example, may provide the necessary competitive advantage to attract new industrial development. Trillium Planning & Development directed this project with the assistance of the Yale University Industrial Environmental Management Program. Mercer County Economic Development and the North Dakota Department of Commerce conceived of and funded the project.

1.2. Scope

The project involved the following three primary tasks:

- An accounting of the assets and resources of Mercer County, the principal area covered under the study
- The benchmarking of projects where similar assets have been commingled into an industrial development area
- An assessment of some types of industries that could take advantage of the resources available in Mercer County and the development of a generalized marketing strategy to capitalize on the resources

In addition to a primary round of facility tours and interviews in August 2004, the project team visited with officials at several of the lignite energy facilities during a second round in March 2005. This second visit was coordinated with a roundtable discussion among project stakeholders in Bismarck.

1.3. Assumptions

Although there are many stakeholders involved in the Coal Country Development Initiative, this final report and the organization of its content is directed largely towards the representatives of Mercer County Economic Development and the North Dakota Department of Commerce. The expressed aims of the report are to assist these public sector organizations in reshaping the business development strategy for Coal Country and to provide important information and tools for new business recruitment.

1.4. Limitations

Several limitations in conducting this project must be noted. These include:

- As with nearly any research endeavor, budget constraints (total budget = $24,719) limited the amount of time that could be devoted to any one area of analysis, e.g. specific industry sectors. In the report we point out topics in which further research is warranted and potential sources for this information.

- The generalized comments on possible attractive potential industries for Coal Country should be considered as an approximate guide only. The identification is in part based on an understanding of the cost structures for these industries, and in some cases a definitive characterization was found to be unfeasible within the budget for this project.
- Information availability: the project team was unable to access certain industry and facility data because of confidentiality concerns. This restricted the analysis in certain industry sectors as well as a prevented a full accounting of the resources at specific facilities.

- The project team largely focused its baseline research on the lignite energy assets of Mercer County. The analyses and findings of the study, however, may be adapted for consideration by economic developers in adjacent counties.

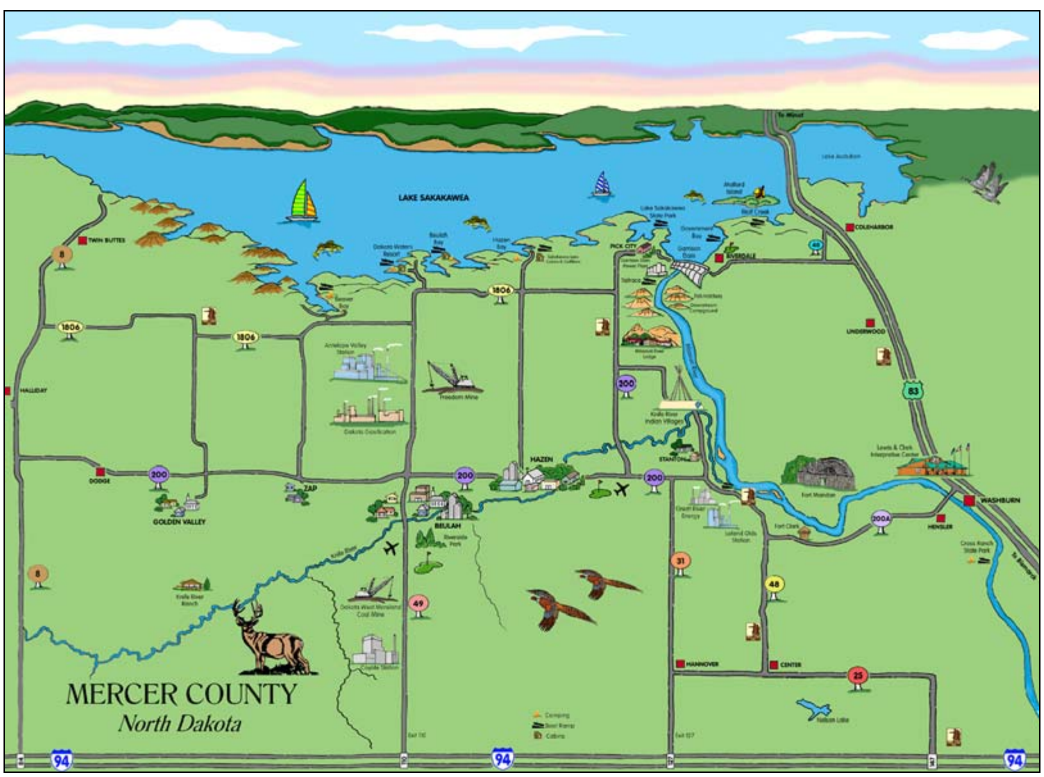
2. Baseline Analyses

Baseline analyses seek to provide a snapshot of existing conditions. For the purposes of this project, the baseline analysis also seeks to characterize the assets and resources that could impact economic development in North Dakota's Coal Country. Armed with this information, those charged with implementing business development and recruitment efforts will be best prepared to market the strengths of the region and mitigate the weaknesses. The characterization is also an attempt to bring all project stakeholders to a common level of understanding of the region's assets and resources. As mentioned in the previous section, this analysis is primarily focused on the assets and resources of Mercer County.

2.1 Mercer County geography and demographics

Mercer County lies in west central North Dakota. According to the United State Census Bureau, the county contains 1,045 square miles of land area and 67 square miles of water, for a total area of 1,112 square miles. It is bordered on the northeast by the Missouri River, on the north by Lake Sakakawea (a reservoir on the Missouri River created by Garrison Dam). Other major physical features include the Knife River which bisects the County, running from southwest to northeast. The County is rural in character and characterized by rolling hills, cultivated for wheat, barley, oats, and hay. The county seat is Stanton and the other major population centers are Beulah, Golden Valley, Hazen, Pick City and Zap. Highway 200 runs east-west, and Highway 49 north-south through the county.

Figure 1: Illustrated Map of Mercer County[1]



The climate of Mercer County is characteristic of the Northern Plains. Extremes of both cold winters and warm summers are possible. Nearly half of the County's annual precipitation of 16.5 inches (recorded in Beulah) occurs from May through July, mostly in the form of thunderstorms. North Dakota averages approximately 2,800 hours of sunshine annually (western half) and has the highest intensity of solar radiation of any state along the Canadian border. Weather statistics for Beulah, North Dakota are provided in the table below:

Figure 2: Beulah, North Dakota Historical Weather Data[2]

Temperature ºF	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Avg. High	22	30	41	58	71	79	85	85	73	60	39	26
Avg. Low	0	9	19	30	41	50	55	54	43	32	18	5
Mean Temp	11	19	30	44	56	65	70	69	58	46	28	16
Avg. Precipitation	0.31	0.42	0.73	1.71	2.21	3.30	2.35	1.53	1.60	1.35	0.70	0.38

According to the 2000 U.S. Census[3], the county was home to 8,644 people, which was a decline from 9,808 in 1990 (the interim census estimate for 2003 was 8,449). In 2000, Mercer County held 3,346 households and 2,445 families. An average of eight people inhabits each square mile, as compared to nearly 80 per square mile across the entire country. The median age was 40 years old, with 29.1% of the population under the age of 18, 4.2% from 18 to 24, 27.5% from 25 to 44, 24.9% from 45 to 64, and 14.3% who were 65 years of age or older. The population of Mercer County is by and large older than the average US population. The average household size was 2.55 and the average family size was 3.05. The county had 101.2 males for every 100 females, but for the population age 18 and over, the ratio was 99.9 males for every 100 females. The per capita income was $18,256, household median income was $42,269, and family median income was $51,983, all slightly above the national average. Median income for males was $47,969 and for females it was $21,667.

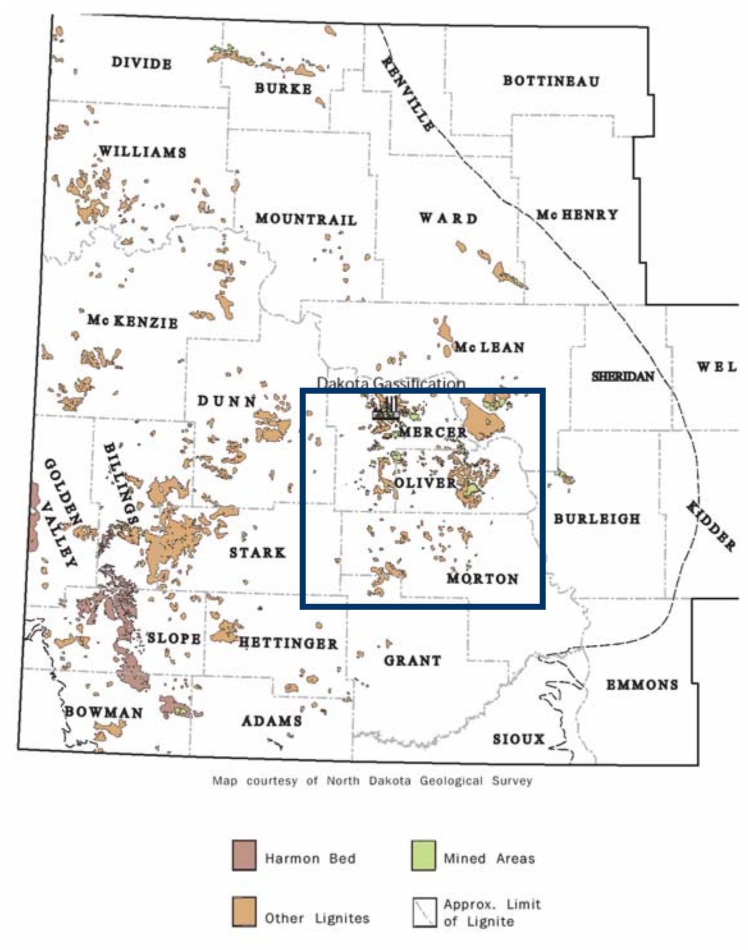
2.2 Commercial & Industrial base

2.2.1 Lignite resource and mines

North Dakota ranks seventh largest among coal producing states, with 35 billion tons of recoverable reserves, mostly in the form of lignite located in the western part of the state[4]. There are four open cast mines in the state, of which Freedom mine and Beulah Mine are located in Mercer County. In 2003, just over 31 million tons of this low-rank coal was extracted from North Dakota's four mines: 15,928,800 tons from Freedom Mine, 2,816,200 tons from Beulah Mine, 7,921,080 tons from Falkirk Mine, and 4,365,000 tons from Center Mine[5]. The coal is used exclusively within the state mostly by utility power plants and by a gasification plant.

Freedom Mine is located seven miles northwest of Beulah, occupying a common industrial site with Basin Electric Cooperative's Antelope Valley Station and the Great Plains Synfuels Plant. Coteau Properties Company, a subsidiary of North American Coal Corporation, owns and operates Freedom Mine. Dakota Coal, a subsidiary of Basin Electric Power Cooperative, finances the operations and markets the lignite from the Freedom Mine. Freedom Mine has 35-45 years of contracts remaining to mine 25,000 acres of land. Of the 16 million tons of lignite produced in 2003, over five million tons was used by the Great Plains Synfuels Plant, five million tons by Antelope Valley Station, four million tons by Leland Olds Station, and one million tons by Stanton Station[6]. Stanton Station has since switched coal suppliers to a sub-bituminous mine in Montana.

Figure 3: North Dakota Coal County's Lignite Deposits[7]



Beulah Mine is located next to Coyote Station, three miles south of the city of Beulah. It is owned and operated by Dakota Westmoreland Coal Company and has been in operation since 1963. Beulah Mine produces about three million tons of lignite per year, delivering about 2.5 million tons per year to Coyote Station and over 0.5 million tons per year to Heskett Station in Mandan. The average heat content of the lignite is 7,000 BTU/lb.

The Freedom and Beulah mines share geologic characteristics. Each has upper and lower coal seams of 7 and 10 feet, respectively, covered by 60-110 feet of sand and clay overburden. The extracted lignite has a heating value of approximately 6,500-7,000 BTU/lb with a sulfur range of 0.7-0.9%) and is low in sulfur (0.7%) and high in moisture (36-38%). Ash content is roughly 7-8%.

Two other mines are located close to Mercer County. Falkirk Mine, operated by Falkirk Mining Company (a subsidiary of North American Coal Corporation), is located near Underwood and Washburn (in McLean County). The mine supplies approximately 8 million tons of lignite to the Coal Creek Station annually. Center Mine is located four miles southeast of Center (in Oliver County). Owned and operated by BNI Coal (a subsidiary of Minnesota Power), it supplies over four million tons of lignite to the Milton R. Young Station.

Figure 4: Coal Country's Major Lignite Mines

Mine	County	Owner/Operator	Reserves (tons)	Annual Production 2003 (tons)	Customer/s
Freedom Mine	Mercer	Coteau Properties (North American Coal Co.)	600 million	15.9 million	Great Plains Synfuels Antelope Valley Station Leland Olds Station
Beulah Mine	Mercer	Westmoreland Coal Co.	44 million	2.8 million	Coyote Station Heskett Station
Falkirk Mine	McLean	Falkirk Mining Co. (North American Coal Co.)	651 million	7.9 million	Coal Creek Station
Center Mine	Oliver	BNI Coal (Minnesota Power)	600 million	4.4 million	Milton Young Station

2.2.2 Power stations

Four lignite-fired power stations are located within Mercer County: Antelope Valley Station, Coyote Station, Leland Olds Station, and Stanton Station. The county is also home (along with McLean County) to the power-producing Garrison Dam. Other lignite-fired power stations in the region include Coal Creek Station (Washburn), Heskett Station (Mandan), and Milton R. Young Station (Center).

Basin Electric Power Cooperative owns and operates Antelope Valley Station, which is located seven miles northwest of Beulah. It has two electric generator units rated at 450 MW each, the first went into operation in 1984 and the second in 1986. AVS consumes about five million tons of lignite annually. The lignite is supplied from neighboring Freedom Mine by a conveyer system[8].

Coyote Station is two miles south of Beulah, next to Beulah Mine. Otter Tail Power Company operates the plant and owns it jointly with Montana-Dakota Utilities Company, Northern Municipal Power Agency and Northwestern Public Service Company. It has one 414 MW generating unit, commissioned in 1981. It consumes about 2.5 million tons of lignite annually, supplied from the neighboring Beulah Mine by a conveyor system[9].

Leland Olds Station is located four miles southeast of the City of Stanton (24 miles east of Beulah), along the Missouri River. Owned and operated by Basin Electric Power Cooperative, it is the oldest of the four power plants in Mercer County. Unit 1, a 210 MW generating unit, was commissioned in 1966 and 440 MW Unit 2 went on-line in 1975. The plant consumes about 4 million tons of lignite annually, mostly supplied from Freedom Mine annually by rail.

Great River Energy owns and operates Stanton Station, which is located next to Leland Olds Station. It has a single 202 MW generating unit, commissioned in 1966. Until recently, the station consumed over one million tons of lignite annually from Freedom Mine. For economic reasons, Stanton switched over to sub-bituminous Powder River Basin coal from Montana at the end of 2004.

Coal Creek Station, with two 550 MW units (operational in 1979 and 1981 respectively), is the largest power generating plant in North Dakota. It is located between Underwood and Washburn (McLean County), and is owned and operated by Great River Energy. It consumes about 8 million tons of lignite annually, supplied from Falkirk Mine.

Heskett Station, owned and operated by Montana-Dakota Utilities Company, is located two miles north of Mandan (Morton County). The first unit, 25 MW, was commissioned in 1954 and put on active standby in 1995. The second unit is 75 MW, and in operation since 1963. It consumes about 0.5 million ton of lignite annually from Beulah Mine.

Milton R. Young Station is located six miles southeast of Center (Oliver County), is owned by Square Butte Electric Cooperative and operated by Minnkota Power Cooperative. Unit 1 is rated at 250 MW and commissioned in 1970; Unit 2 is rated at 455 MW and commissioned in 1977. It consumes over four million tons of lignite annual, supplied from Center Mine.

Finally, Garrison Dam is located on the Missouri River near Riverdale, about 80 miles north of Bismarck. Construction began in 1947, and was completed in 1954 at a cost of $294 million. The dam has a hydroelectric power station rated at 500 MW, and operated by the U.S. Army Corps of Engineers.

Figure 5: Coal Country Lignite Power Stations

Power Station	County	Owner/s	Fuel Source	Rating
Antelope Valley (1984)	Mercer	Basin Electric Cooperative	Freedom Mine (mine mouth)	2 x 450 MW
Coyote (1981)	Mercer	Otter Tail Power, Northern Municipal Power Agency, MDU, NW Public Service	Beulah Mine (mine mouth)	414 MW
Stanton (1966)	Mercer	Great River Energy	Powder River Basin (rail)	202 MW
Leland Olds (1966)	Mercer	Basin Electric	Freedom Mine (rail)	Unit 1 @210 MW Unit 2 @ 440 MW
Coal Creek (1979)	McLean	Great River Energy	Falkirk Mine (mine mouth)	2 x 550 MW
Milton Young (1970)	Oliver	Square Butte Electric Cooperative	Center Mine (mine mouth)	Unit 1 @ 250 MW (inactive) Unit 2 @ 455 MW
Heskett (1955)	Morton	Montana-Dakota Utilities	Beulah Mine (rail)	Unit 1 @ 25 MW (inactive) Unit 2 @ 75 MW

2.2.3 Coal gasification plant

Dakota Gasification Company, a subsidiary of Basin Electric Power Cooperative, owns and operates the Great Plains Synfuels Plant. The Great Plains Synfuels Plant is the third largest gasification plant in the world, and the only commercial scale coal gasification plant in the United States, delivering 51.2 billion cubic feet of synthetic natural gas to market in 2003. The synfuels complex cost $2.1 billion to construct and began operations in 1984. The plant is located five miles northwest of Beulah, adjacent to the Freedom Mine and Antelope Valley Station. Great Plains Synfuels Plant and Antelope Valley Station share site access, water intake, delivery and storage facilities and lignite feedstock supply from Freedom Mine. Great Plains Synfuels uses 14 Lurgi dry ash gasifiers. In 2003, Great Plains Synfuels Plant consumed approximately 6.1 million tons of lignite. While substitute natural gas is the primary product, Dakota Gasification had significantly increased its production and revenues from gasification byproducts from 8.9% in 1995 to 38.2% in 2003[10].

Figure 6: Great Plains Synfuels Process Flow[11]

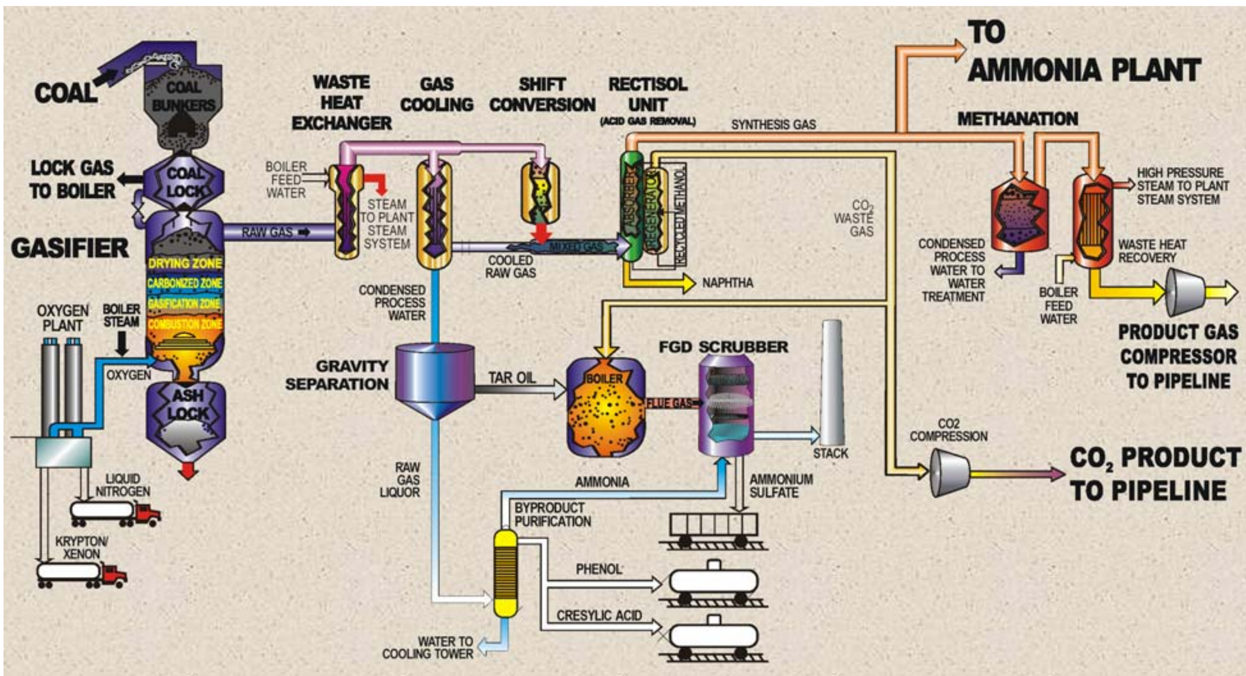


Figure 7: Great Plains Synfuels Products[12]

Compound	2003 Deliveries	Notes
Actual Deliveries		
Substitute natural gas (syngas)	51,200 million ft^3	Sold through the regional natural gas pipelines for distribution in eastern U.S. Sufficient to power a 550-700 MW power plant.
Anhydrous ammonia	208,000 tons	Widely used fertilizer applied directly to crops. Small percentage used for refrigerant and feedstock for chemical production.
Ammonium sulfate	109,000 tons	Produced from flue gas desulfurization. Agricultural fertilizer marketed under the name, Dak Sul 45®.
Phenol	28.2 million lbs	Used in plywood manufacturing for the production of resins and in the casting industry.
Cresylic acid	30.0 million lbs	Used in the manufacture of pesticides and products such as wire enamel solvent, phenolic and epoxy resins and antioxidants.
Liquid nitrogen	183,000 gallons	Used for food processing refrigeration, an oil well additive and in chemical processes.
Carbon dioxide	29.3 billion ft^3	Piped to Canada for enhanced oil recovery by injecting into old oil wells
Naphtha	2.8 million gallons	Contains products used as a gasoline blend stock, in making solvents and in benzene production.
Tar Oil	132,000 gallons	Excess boiler fuel
Krypton-xenon	3.3 million liters	Krypton and xenon gases used for specialty lighting, such as high-intensity lighting and lasers, and for thermopane window insulation. Currently not marketed.
Potential Production		
Argon	Up to 100 tons/day	
Cresylic Acid	Up to 40 million lbs/yr	Byproduct recovered from tar oil
Phenol	Up to 10 million lbs/yr	Byproduct recovered from tar oil
Transportation fuels	Not Available	Could produce from syngas

2.3. *Agricultural base*

North Dakota is home to 40 million acres of farmland, or 90% of the state's land area.[13] Production agriculture is the largest private industry in the state, generating $3.6 billion in cash receipts in 2002, and forming 25% of the state's economic base[14]. Within the state, there are 30,619 farms in North Dakota occupying an area of 39,294,879 acres. More than 40% of the farms are larger than 1,000 acres each. Over 65% of the farmland is cropland, and over 25% pasture[15].

North Dakota is a top producer of many essential crops like grains, oil seeds and dry beans. The tables below show the North Dakota's top agricultural commodities and overall U.S. ranking. A large percentage of land is cultivated with small grains, including hard red spring wheat (10 million acres), durum wheat (2.5 million acres), barley (2.5 million acres), and other small grains like rye, winter wheat and oats. Oilseed crops, such as flax, sunflower, safflower and canola, as well as row crops such as dry beans, soybeans, sugarbeets, and corn are common across the state. Vegetables are a major crop in the Red River Valley region in the east of the state. Commercial potatoes and seed potatoes are cultivated on about 160,000 acres and 30,000 acres, respectively. However, potato production is moving westwards because of increasing irrigation prospects. Farms in the state also cultivate other specialty crops such as lentils, lupines, field peas, and chickpeas[16].

Figure 8: North Dakota's Top Agricultural Commodities[17] and Rank in US 2002[18]

Commodity	Percentage of Total Cash Receipts[1/]
Wheat	25.1
Cattle and Calves	18.3
Soybeans	13.6
Barley	6.3
Corn	6.0
Sugarbeets	5.2
Sunflower	5.1
Canola	3.8
Dry Edible Beans	3.5
Potatoes	3.1
Milk	1.8
Hay	1.7
Flaxseed	1.6
Honey	1.1
Other Crops	1.1
Hogs	0.8
Other Livestock	0.5
Dry Edible Peas	0.4
Oats	0.3
Lentils	0.2
Turkeys	0.3
Sheep and Lambs	0.2

Rank	Commodity	Percent of nation's production
#1	Spring Wheat	48%
	Durum Wheat	60%
	Barley	43%
	Oats	15%
	Canola	90%
	All Sunflower	57%
	Oil Sunflower	59%
	Non-oil Sunflower	48%
	Flaxseed	95%
	All Dry Edible Beans	35%
	Navy Beans	46%
	Pinto Beans	56%
	Dry Edible Peas	53%
#2	All Wheat	14%
	Lentils	26%
	Honey	16%
#3	Sugarbeets	17%
	Rye	9%
#4	Potatoes	6%
#10	Soybeans	4%

Mercer County, even with its large open pit mining and industry base, mirrors the state in percentage of land area devoted to agriculture. According to the last Census of Agriculture (2002), Mercer County had 536,339 acres of farmland or 80% of the total land area. Approximately 45% of this farmland was cultivated and 52% was pasture. The number of farms in the county was 456 with an average size 1,176 acres. The market value of farm production in the County was $22,252,000. Livestock sales accounted for $12,237,000 of the total, while crop sales accounted for $10,015,000. The top five crops in Mercer County (in acres planted) were wheat (72,076 acres), barley (66,122 acres), barley (9,545 acres), sunflowers (6,160 acres) and oats (5,390 acres).[19]

Figure 9: US Agricultural Statistics Maps for Selected Crops 2004

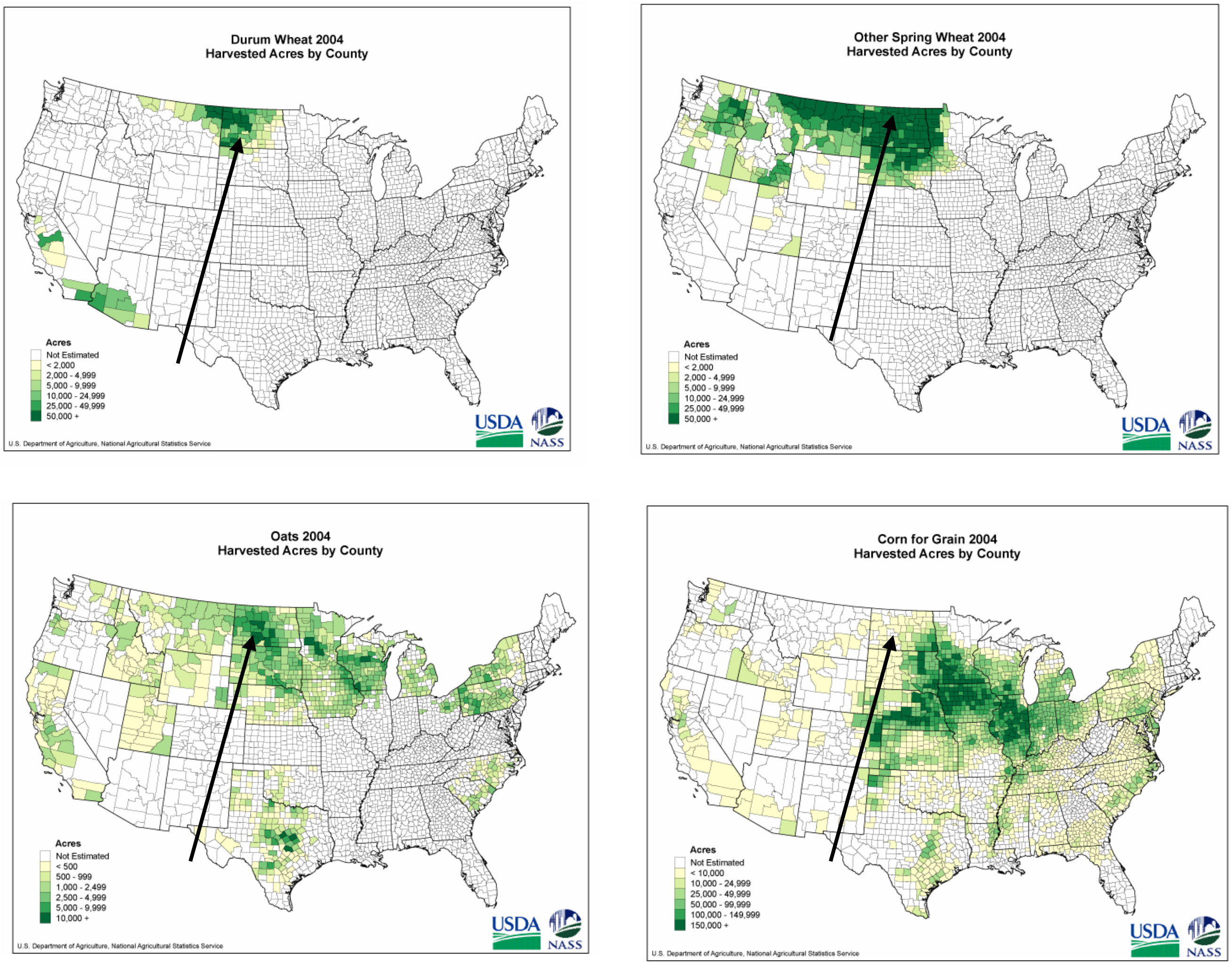
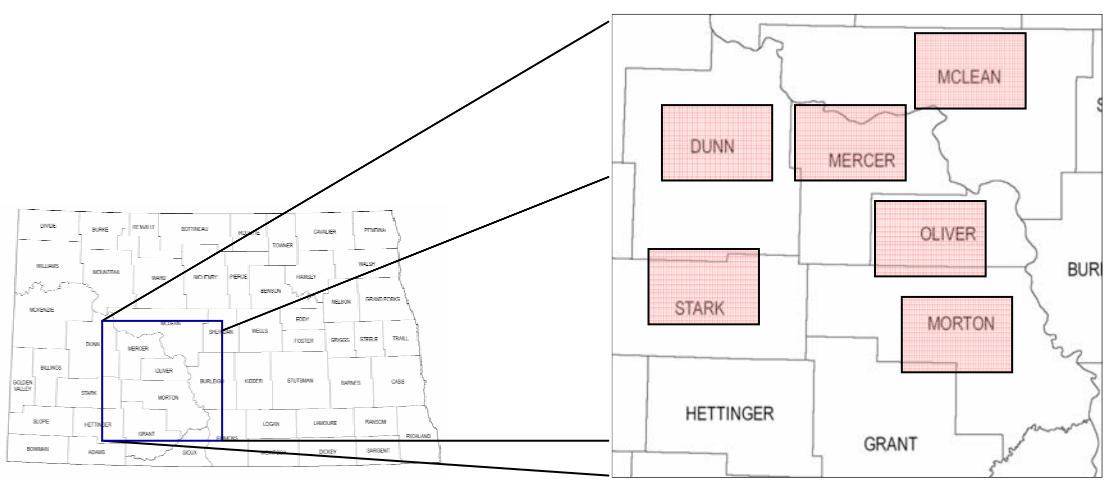


Figure 10: Map of Mercer and Adjacent Counties[20]



In consideration of industrial development potential based on the region's agriculture production, the baseline characterization focused on Mercer County and five contiguous counties (see Figure 10). These six counties comprise a 50-80 mile radius from the Beulah area. The following table provides production data for seven crops and cattle ranked as a percentage of the State's total production of that commodity in 2004. As is reflected in the table the six-country region is home to roughly 20% of the oats, cattle and flaxseed produced in the state, which is significant considering North Dakota's large presence in these commodities nationally. The six county region is also a major contributor (approximately 10%) to the state's durum and spring wheat, sunflowers, and canola production. If adjacent counties immediately to the north of this six county region are included in the analysis, both the wheat and canola production numbers would rise dramatically.

Figure 11: Agricultural Statistics for Mercer County and Environs 2004 [21]

Crop	Mercer		Total 6 Counties		Total State	% of State
Oats (bu)	400,000		3,113,000		14,080,000	22%
Cattle	44,000		369,000		1,750,000	21%
Flaxseed (bu)	85,000		1,823,000		9,943,000	18%
Wheat (bu)	2,552,000		34,590,000		306,650,000	11%
Sunflower (lbs)	9,740,000	*	84,070,000	*	791,700,000	11%
Canola (lbs)	7,270,000		120,750,000		1,222,500,000	10%
Barley (bu)	1,010,000		8,245,000		91,760,000	9%
Corn (bu)	143,000	*	1,112,000	*	120,750,000	1%

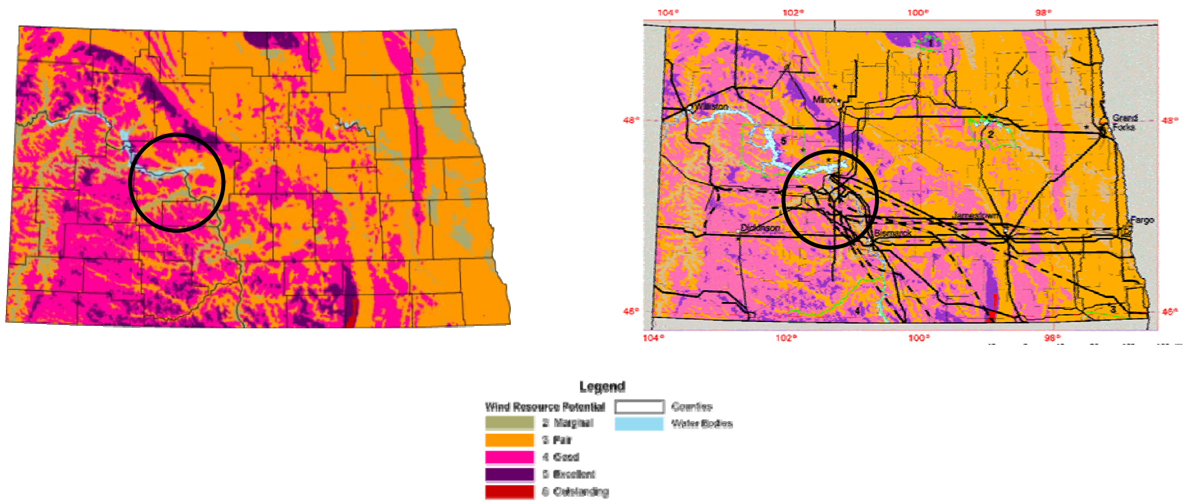
2.4. Other Resources

North Dakota is the ninth largest oil producing state, producing nearly 31 million barrels of oil per year (90,000 barrels per day) in 2002[22]. Oil producing areas are located in the west in 17 counties. The state has one oil refinery located near Mandan (Morton County), owned by Tesoro Corporation, capable of refining 60,000 barrels of crude oil per day into gasoline, diesel fuel, jet fuel, propane, and butane. The largest utility petroleum power station is Jamestown Station (Stutsman County), a 48 MW station operated by Otter Tail Power Company.

A 1991 study performed for National Renewable Energy Laboratory estimates that North Dakota has potential wind energy generation capacity of 1,210 billion kWh per year[23], the highest among the contiguous states[24]. This is equivalent to 138,000 MW of generating capacity if calculated at a 100% capacity factor. North Dakota currently has 66.3 MW of generating capacity. The two largest wind farms are located in Lamoure County and are owned and operated by FPL Energy. One farm is located in Edgeley with a 40.5 MW rated capacity (power purchased by Basin Electric Power Cooperative) and other rated at 21 MW is in the town of Kulm (power purchased by Otter Tail Power Company). The remaining 5 MW are located in seven sites around the state[25]. In a move that would quadruple the states' production capacity, PPM (an American subsidiary of Scottish Power), announced intentions to construct a 150 MW wind farm near the town of Rugby in Pierce County.

On average, the counties comprising North Dakota's Coal Country are considered to have above average wind resources for the State. As can be seen in maps below most of the area is rated Class 4 (7-7.5 meters/second). Unlike many other parts of the state with above average wind energy potential, Coal Country has considerable transmission infrastructure. Access to existing transmission and integration of the variable electricity production of wind turbines remain challenges to be overcome.

Figure 12: North Dakota's Wind Energy Resource & Transmission Infrastructure[26]



2.5. Land

Mercer County and Coal Country have no shortage of land suitable for development. However the unimproved property immediately surrounding the region's power stations and gasification plant is often restricted, for a variety of reasons. The land adjoining Otter Tail Power Company's Coyote Station, for example, varies dramatically in elevation such that new industrial development would need to occur immediately adjacent to the plant (west of the cooling towers or north of the plant's coal pile). Coyote Station also has a vacant metal panel building that could be leased for by a third party user.

Just west of Antelope Valley Station is 24-acre area that until recently was reserved for new industrial development. This area, formerly known as the Mercer County Cooperative Energy Park was recently vacated for coal hauling as the Freedom Mine opens up new pits south of AVS. Mercer County and AVS had installed an18-inch hot water pipeline from the station's cooling towers to the Energy Park. The greatest potential for future industrial development near AVS and the Great Plains Synfuels plant now appears to be the relatively level reclaimed lands east of the two facilities.

Both Stanton and Leland Olds stations are constrained to the north by the Missouri River, but both power stations have ample potentially developable land to the south (across State Highway 200). The following aerial photographs, while dated (1995), provide a rough guide of the land use and infrastructure in the vicinity of the four Mercer County power stations and gasification plant. Where available in the county potentially developable sites are superimposed.

Figure 13: Aerial Photo of Vicinity Coyote Station

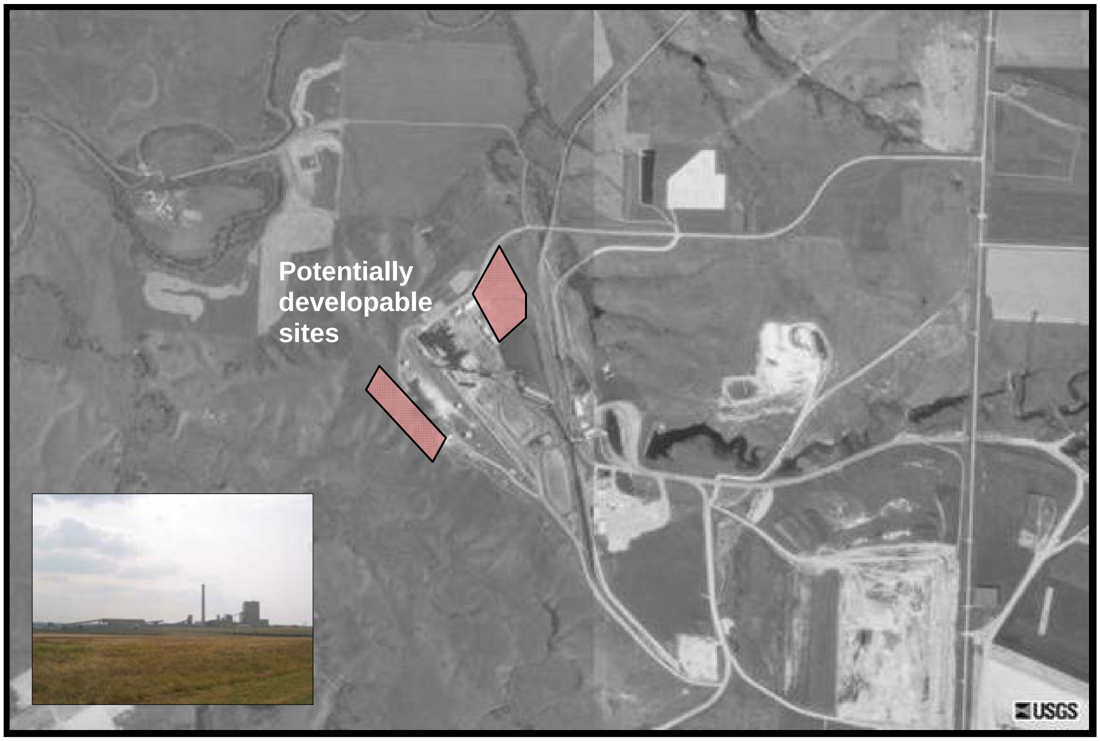


Figure 14: Aerial Photo of Vicinity of Great Plains Synfuels and AVS

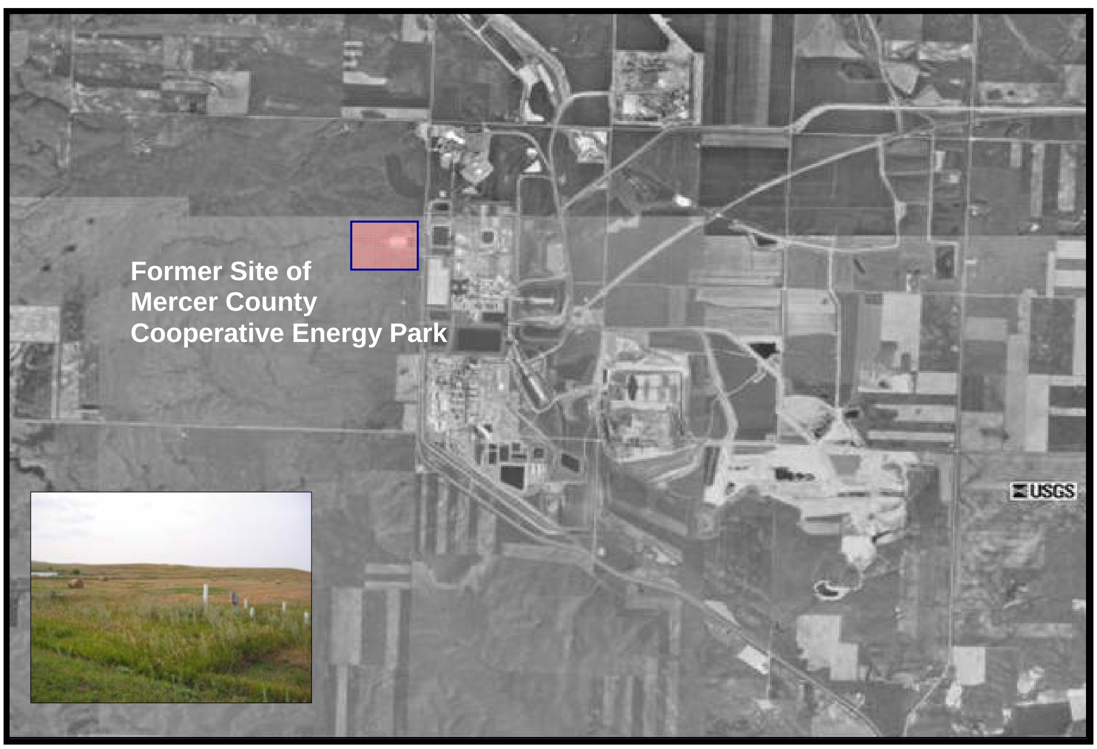
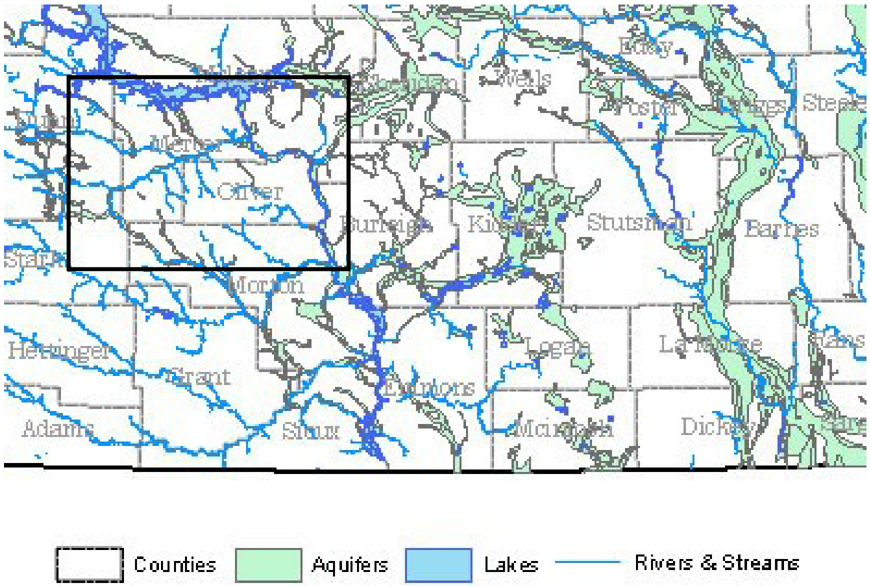


Figure 15: Aerial Photo of Vicinity of Stanton Station and Leland Olds Station

2.6. Water

Mercer County has both groundwater and surface water resources. The main surface water sources are the Missouri River, Lake Sakakawea and the Knife River. The Missouri River flows in a general north-west to south-east direction, and it borders the north-eastern corner of the county. Lake Sakakawea is formed by Garrison Dam on the Missouri River; and is the third largest man-made lake in the U.S. with a surface area of 368,000 acres and water storage of 23 million acre feet. It is the northern boundary of Mercer County. It should be noted that several of the power stations have excess capacity in both water permits and pipeline infrastructure, potentially serving new small scale water users directly without the need for new permits. Larger appropriation rights for surface water would be applied for through the North Dakota State Water Commission. Approval to draw from Lake Sakakawea is likely to require additional approval from the U.S. Army Corp of Engineers because of their jurisdiction over Garrison Dam. Currently, water rights are issued in the following “header use type” categories: Commercial, Fish and Wildlife, Flood Control, Industrial, Irrigation, Multiple Use, Municipal, Power Generation, Recreation, Rural Water, and Stock. Water can be diverted from the Missouri River, Lake Sakakawea, the Knife River and Yellowstone River, and applicants must declare annual draw rates. The state applies restrictions to water to protect senior water rights and North Dakota State Department of Health discharge requirements.

Figure 16: Coal Country's Aquifers and Surface Waters



Beulah draws from groundwater mainly for municipal and commercial uses within the city limits; the municipality operates a water treatment plant capable of handling 2.5 million gallons per day. Groundwater in the area is known for its high dissolved solids content. Antelope Valley Station operates a raw water pipeline from Lake Sakakawea and water pre-treatment facility supplying their station and Great Plains Synfuels Plant. Further water treatment is performed by the respective facilities. Coyote Station draws their water from the Missouri River. Leland Olds and Stanton Stations also draw water from the adjacent Missouri River.

2.7. Electricity

Three investor-owned electric utility companies operate in North Dakota: Xcel Energy, Otter Tail Power Company, and Montana Dakota Utilities. The state is also home to five generation and transmission cooperatives (including Basin Electric Cooperative, Minnkota Power Cooperative and Great River Energy) and 17 distribution cooperatives. In 2004, the average revenue per kWh in North Dakota was as follows:

Figure 17: North Dakota: Average Revenue of Electricity Generation[27]

	Residential (¢/kWh)	Commercial (¢/kWh)	Industrial (¢/kWh)	All Sectors (¢/kWh)
Average Revenue Per kWh	6.62	5.87	4.16	5.57

Mercer County is served by two electricity providers: Montana Dakota Utilities (MDU) and Oliver-Mercer Electric Cooperative. The southwestern portion of the country encompassing

Coyote Station lies within MDU's service territory, while the balance of the country is served by Oliver-Mercer. The following graph represents the industrial rate schedules for the two providers. Details for both are provided in the Appendix.

Figure 18: Mercer County Industrial Electricity Rates[28]

Provider	Rate	Demand Charge ($/kW)	Energy Charge (¢/kWh)
MDU	Rate 30	$5.254 (Oct-May) $8.254 (Jun-Sep)	3.255¢
Oliver Mercer	Schedule B Large Power	$5.00	4.60¢

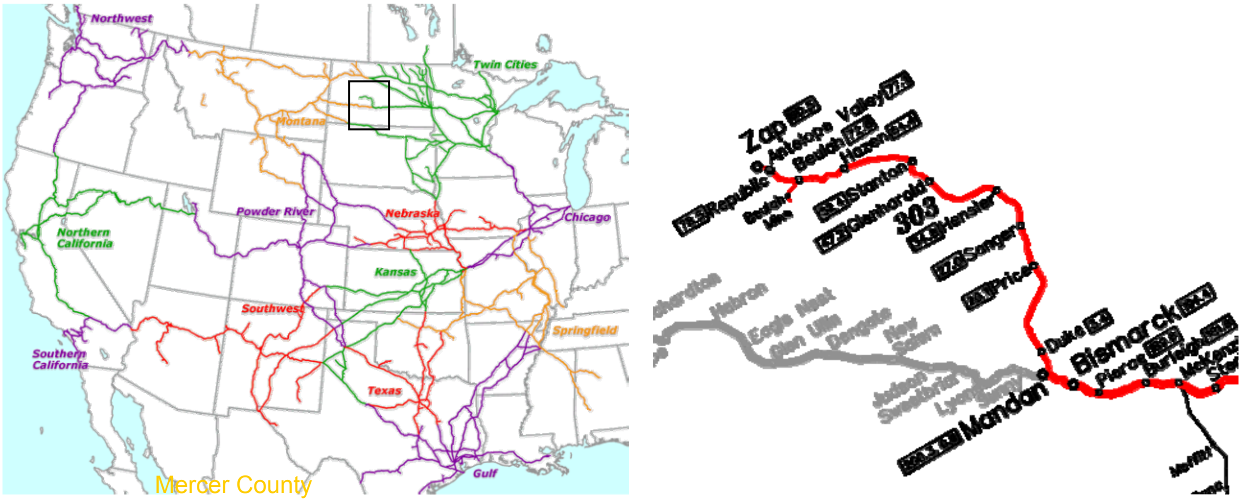
2.8. Transportation

Though transportation in Coal Country is plentiful – rail service at all plant sites and an interstate only 30 miles south – people frequently cite the cost of transportation as an impediment to the development of manufacturing in the region. The lack of competition on the spur rail line serving the county is considered the source of this high cost.

Federal Interstate 94, and North Dakota State Highways 200 and 49 serve Mercer County. The closest air service is at Beulah Municipal Airport, which has a 4,000 ft long by 60 ft wide asphalt surface runway. The closest commercial airports are at Bismarck (80 miles from Beulah) and Minot (100 miles).

BNSF Railway owns and operates the county's rail system with a branch track (of the Twin Cities Division) originating in Zap and continuing through Antelope Valley, Beulah, Hazen, Stanton, and connecting to the main track in Mandan. BNSF Railway is a subsidiary of Burlington Northern Santa Fe Corporation and operates one of the largest railroad networks in North America, with 32,000 route miles in 28 states and two Canadian provinces.[29] However, according to many of County's energy professionals, the monopoly nature of the rail service in the county, and the ensuing pricing power of BNSF, have beleaguered the area's energy industry. Great River Energy's Coal Creek station appears somewhat better positioned as it is served by the regional provider Dakota, Missouri Valley & Western Railroad, linking the plant with the corn and soybean rich counties of southeastern North Dakota.

Figure 19: BNSF Railway Network[30]



BNSF was queried for sample pricing of transporting several commodities (May 2005). The results are depicted in the table below on a per car basis. Details of the pricing queries are provided in the appendix. It should be noted that BNSF recently instituted the nation's first mileage-based fuel surcharge to better manage the extreme fluctuations in fuel prices more effectively. Previous surcharges were based on a customer's total freight transportation bill.[31]

Figure 20: BNSF Freight Transportation Rates for Selected Commodities[32]

Origin	Destination	System Miles	Price Per Carload		
			Bricks	Gypsum Drywall	Non-Perishable Food
Antelope Valley	Minneapolis	521	$1,912	$2,453	$1,756
Stanton	Chicago	929	$2,825	$3,462	$2,583

2.9. Sum of Resources at Mercer County Energy Facilities

After accounting for the region's resources in aggregate form, the project team set out to inventory the resources available at specific industrial development sites. Given this project's emphasis on synergies with existing energy assets, only sites adjacent to or near Mercer County's energy facilities are examined. The following graph provides a summary of the potential resources available at these five facilities: Coyote Station, AVS, Great Plains Synfuels, Stanton Station, and Leland Olds Station. Only publicly available data is listed for Antelope Valley and Leland Old Stations, owned by Basin Electric Cooperative. The resources available at Coal Creek Station in McLean County are also included for comparison.

All of the reporting plants have land, hot water, steam, and a variety of ash products available. Most have services, such as security and fire safety available as well.

Use of steam and hot water by third parties appear the most attractive drivers for industrial development around Coyote Station. While Coyote's bottom ash has been used as an abrasive for sandblasting, it is unlikely that such recycling could propel an economic development opportunity in Mercer County. Coyote's fly ash is said to have excessive sodium for the purposes of concrete substitution. While confirmation of this finding is beyond the scope of this study, it may be possible to pursue use of the fly ash in non-structural concrete applications such as decorative uses.

A similar situation exists at Antelope Valley Station. While Antelope Valley has ample bottom ash and fly ash by volume, the demand for bottom ash is not sufficient and the chemistry of the fly ash produced by coal from Freedom Mine is not well suited for use as a concrete substitute. Antelope Valley Station has the highest volume of hot water of the four Mercer County power stations, and may have significant steam extraction opportunities as well, though this has not been confirmed[33]. The existing piping infrastructure for hot water utilization at the Mercer County Energy Park makes this site particularly attractive for a greenhouse or aquaculture facility. However, a previous attempt at operating an aquaculture facility at the Energy Park has left many in the region with a negative outlook on this industry.

The Energy Park and other possible sites in the vicinity of Antelope Valley Station also provide opportunities for capturing the byproducts of energy and material byproducts of the Great Plains Synfuels Plant. Facility management has documented the availability of high quality steam and relatively consistent temperature hot water resources. Management has also expressed interest in the increased use of phenol, cresylic acid, and the noble gases. Options for use of these byproducts will be addressed in the recommendations section.

Stanton Station has both fly ash and excess steam available for use.

Leland Olds Station had not yet reported data at the time of this report, but its collocation with Stanton Station provides the opportunity for collaborative development projects. However, both complications and new opportunities are presented by Basin Electric Power Cooperative's intentions of repowering one of the plant's boilers with an integrated gasification combined-cycle unit or other technology.

Figure 21: Energy Facility Resources

Potential Resources	Coyote 414 MW Power Station	Antelope Valley 900 MW Power Station	Great Plains Synfuels 50 billion ft/yr Syngas Plant	Leland Olds 650 MW Power Station	Stanton 202 MW Power Station	Coal Creek 1,100 MW Power Station
Land	2500 acres owned around plant site; two areas immediately northeast (30 acres) and west (25 acres) of the plant may be available for land lease; rolling hills are prevalent away from the site	24-acre industrial park west of plant (Mercer County Cooperative Energy Park) is vacated for coal truck traffic; considerable open land to east of station (reclaimed)	Adjacent to AVS; past proposals have explored use of land south of plant; similar to AVS, considerable open land east of plant (reclaimed)	Both Leland Olds and Stanton are constrained to the north by the Missouri River but have abundant land south of the co-located facilities	Both Leland Olds and Stanton are constrained to the north by the Missouri River but have abundant land south of the co-located facilities	
Thermal						
Steam	100,000 lbs/hr available without plant modification; Volumes are negotiable and based on quality needed	No steam available	Two sources: No.1: 100,000 lbs/hr @ 25 lb sat, relatively consistent year round; No. 2: 25,000-100,000 lbs/hr @ 50 lb sat, high range available in summer	Some low pressure steam may be available	1800 psi at 350,000 lbs/hr (can be conditioned to meet needs)	500,000 lbs/hr at above 150 psi
Hot Water	160,000 gpm, 90% availability, 90F to 120F (avg 95F winter & 110F in summer); consists of Missouri River water cycled up about eleven times.	2 x 187,000 gpm; 75F to 115F (avg 95F summer & 110F summer) based on 1988 data	125,000 gpm, 115 F to 120 F, more stable temperatures than power stations but higher solids content; necessary heat exchangers would be deployed at DGC	Volume, characteristics not reported	None	200,000 gpm, 68-98F, more stable temps of 80-85F available at 7000 gpm.
Electricity	MDU Rate 30; demand charge @ $5.25-$8.25/kW; energy charge @ $0.0326/kWh	Oliver Mercer Electric Coop Schedule B; demand charge @ $5.00/kW, Energy charge @ $0.046/kWh	Oliver Mercer Electric Coop Schedule B; demand charge @ $5.00/kW, Energy charge @ $0.046/kWh	Oliver Mercer Electric Coop Schedule B; demand charge @ $5.00/kW, Energy charge @ $0.046/kWh	Oliver Mercer Electric Coop Schedule B; demand charge @ $5.00/kW, Energy charge @ $0.046/kWh	McLean Electric Supplier
Natural Gas	Not Available; propane, electricity, and fuel oil are the only other heating resources	Not available		None	None	None
Carbon Dioxide	None	None	Food grade CO_2 possible from ammonia plant; product contains CO and water (clean up requires liquefaction/de-hydration); clean-up and storage requires new capital investment; have costs for 44 ton/day production unit	None	None	None
Water						
Raw water	Excess infrastructure capacity of 10,000 acre feet/yr. Industrial user would need their own water appropriations permit from the State to extract the water from the Missouri River; Pumping costs range from 10-15 cents per 1000 gals			Leland Olds draw 350,941 acre feet per year from Missouri River for cooling towers; any additional water demand would require new permits	None	7000 gpm of Missouri River water
Potable water	Water is treated on site for potable use and demineralized for boiler use. This cost ranges between $1 and $2 per 1000 gals			292 acre feet per year	None	300 gpm of treated water and 200 gpm of demineralized water
Fire water	Yes				None	yes

Figure 21: Energy Facility Resources (continued)

Potential Resources	Coyote 414 MW Power Station	Antelope Valley 900 MW Power Station	Great Plains Synfuels 50 billion ft/yr Syngas Plant	Leland Olds 650 MW Power Station	Stanton 202 MW Power Station	Coal Creek 1100 MW Power Station
Sewer / Wastewater						
Sewer	Yes				Yes	Yes
Wastewater	Yes				Yes	Yes
Rail access	BNSF (spur at site)	BNSF (spur at site)	BNSF (spur at site)	BNSF (spur at site)	BNSF (spur at site)	DMVW (short-line at site) Connects to BNSF and CP main lines
Security	Access is restricted				Yes	Yes
Other	Warehouse available on-site with racks & bins; also 2,000,000 gallons fuel oil storage capability					On site machinist and welding facilities, EMTs, incipient fire response team, and rope rescue team
Coal Combustion Products						
Fly Ash	Commingled with FGD (see below)			141,000 tons per year	Commingled with FGD (see below)	525,000 tons/yr, $3.75/ ton disposal cost
Bottom Ash	150,000 tons/yr; currently pay $1.00/ton to manage			174,100 tons per year	8,000 tons per year $3.75 per ton	300,000 tons/yr, $3.75/ ton disposal cost
FGD Products	350,000 tons/yr; currently pay $2.50/ton to manage (lime reagent dry scrubber with flyash recycle)			NA	40,000 tons per year $3.75 per ton	90,000 tons/yr, $3.75/ton disposal cost
Notes	Any industrial partner emissions would need to be compatible w/ existing permits and regulatory limitations					Cost for materials and services would be discussed with potential partners

2.10. *Labor Force*

Mercer, Oliver, and neighboring counties have a very high concentration of skilled labor. With a labor force of over 9,000, more than 60% have vocational training, a college degree or higher, and another 30% have at least a high school diploma. The charts below show the breakdown of occupational types and available labor in the region. The data for this study was collected from a random survey that included all of Mercer and Oliver, and portions of Dunn, Morton and McLean counties. A special note regarding labor availability: an individual is considered "available labor" if he or she is 18 or over and actively seeking work, planning to look for work within the year, willing to change employers, or willing to take on additional work, as well as those individuals who are not working or looking for work but have a salary or wage requirement.

Figure 22: Employment Distribution By Education Level, Spring 2004[34]

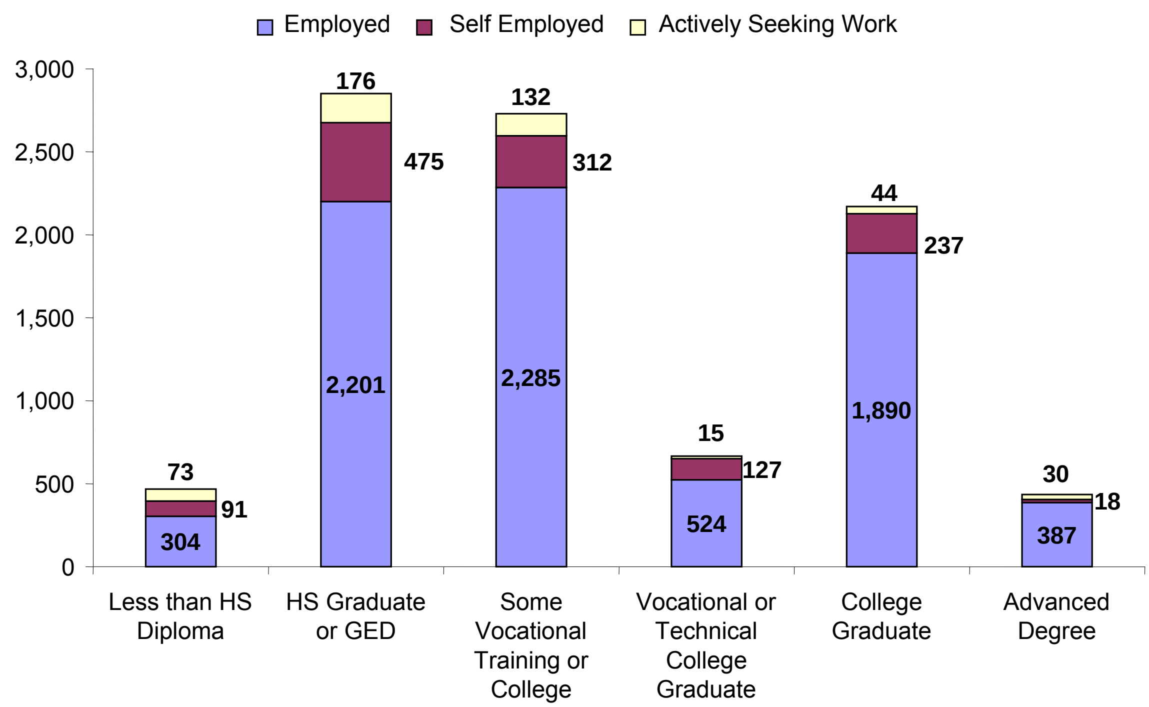


Figure 23: Employment Distribution: By Occupation[35]

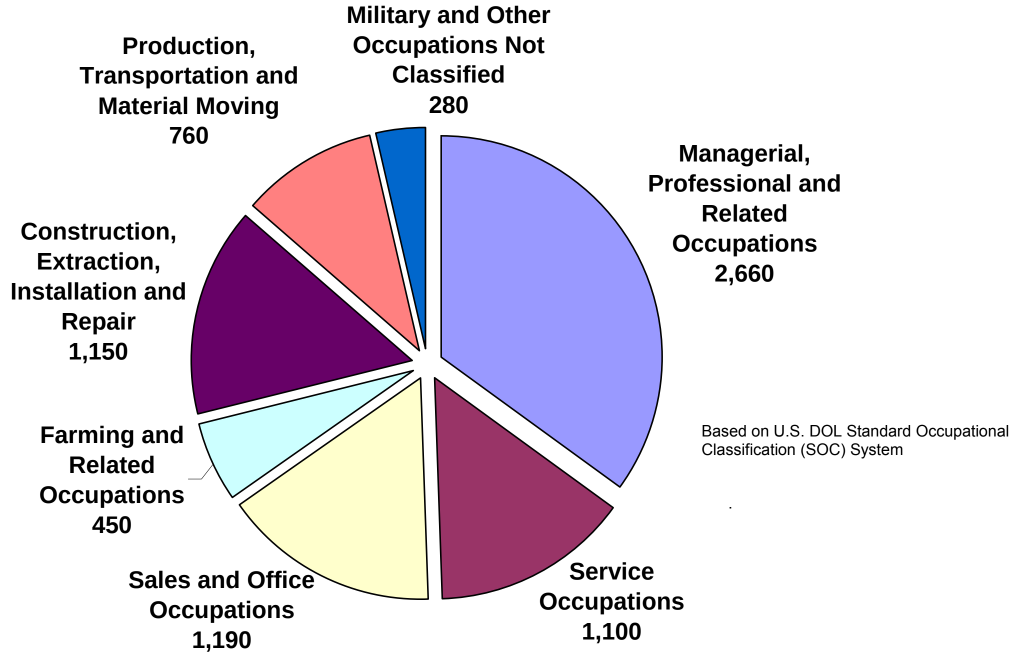


Figure 24: Labor Availability by Education, Spring 2004[36]

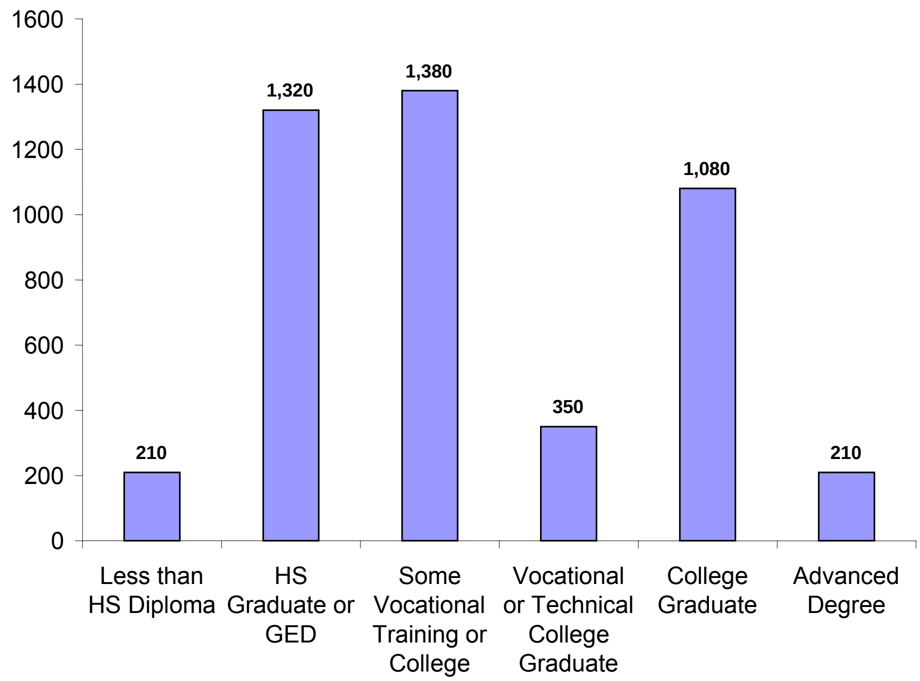
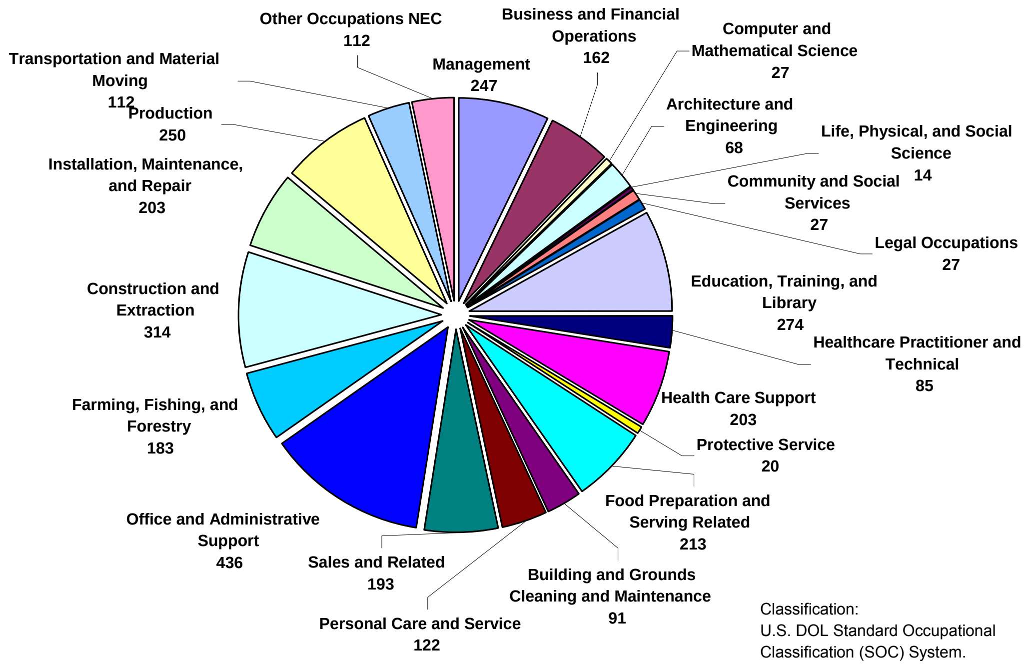


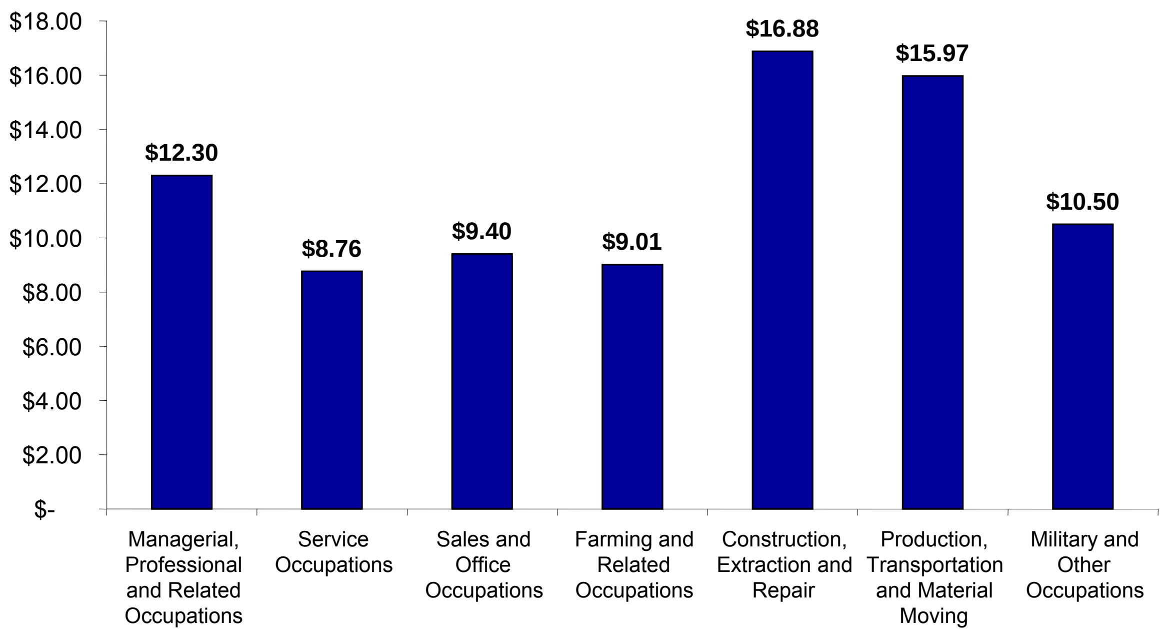
Figure 25: Labor Availability By Occupation, Spring 2004[37]



:

Classification:
U.S. DOL Standard Occupational Classification (SOC) System.

Figure 26: Minimum Acceptable Average Wage, Spring 2004[38]



2.11. *Institutions and Organizations*

In addition to the considerable energy, material, infrastructure and labor resources present in Mercer County and greater Coal Country, the region derives enormous economic development potential from its intellectual assets. A comprehensive listing of these assets is provided in the following table.

Figure 27: Coal Country Intellectual Assets

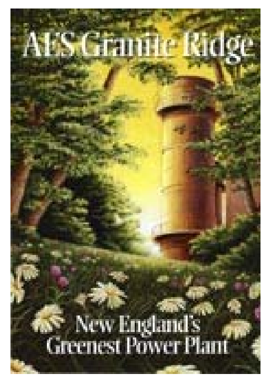
Sector	Organization
Industry	• Basin Electric Power Cooperative • Otter Tail Power Company • Great River Energy • North American Coal Corporation • Westmoreland Coal Company • Montana Dakota Utilities • BNI Coal • Oliver-Mercer Electric Cooperative • Tesoro Corporation
Industry Trade Associations	• Lignite Energy Council • North Dakota Petroleum Council • North Dakota Agricultural Association • North Dakota Farm Bureau • Northern Canola Growers Association • North Dakota Soybean Council • North Dakota Corn Growers
Local & State Government	• Mercer County Economic Development • North Dakota Department of Commerce - Economic Development & Finance • North Dakota Department of Agriculture • Bank of North Dakota • Job Service North Dakota
Academic/Research Institutions	• University of North Dakota - Energy and Environment Research Center • Bismarck State College • North Dakota State University - Extension centers • Dickinson State University • Minot State University, Minot, Ward County • USDA Northern Great Plains Research Lab

3. Benchmarking

To understand the factors contributing to project successes and failures more completely, the principal investigators undertook a benchmarking exercise of selected industrial development projects involving the networking of independent firms. This was done with the belief that possible industries that would locate in the county would likely want to collocate with some of the existing industries to benefit from shared assets. The benchmarking effort was mostly of US-based projects, but included two projects in Canada, one in South Africa, and another in Germany. Selected cases are described in detail below and are followed by a summary table of all the projects. In addition to understanding the origins and evolution of other initiatives, the benchmarking exercise provides the opportunity to identify common success factors and mistakes.

3.1. Londonderry Eco Park

The 100-acre Londonderry Eco Park was conceived as an eco-industrial park by municipal economic development officers and a local food processor (Stonyfield Farms). The Park was initially owned by the City of Londonderry but later sold to a private developer (eventually known as Sustainable Design & Development, LLC) with encumbrances in the form of eco-industrial "codes, covenants and restrictions". The private developer was initially rather skeptical of the concept but grew increasingly intrigued when both a major power producer (AES) and a German-based HVAC equipment manufacturer (Buderus) discovered the project specifically because of its attention to the concerns of sustainable development. Both firms located in the park, AES constructing a 730 MW combined-cycle power station, and the German firm building a 50,000 square foot regional distribution center.



Front Cover of Conservation Matters Summer 2002

The development benefits from a strategic location adjacent to a fast-growing regional airport, and is roughly 80 percent full. The combined-cycle power plant held the initial promise of cogeneration opportunities with neighboring companies, in particular Stonyfield Farms, but the low-grade quality of the remaining energy was found to be insufficient for most prospective users and the financial woes of the plant (no long-term power contracts) later consumed AES officials. The Park development did involve a mutually beneficial arrangement between AES and the City of Manchester in which Manchester's treated wastewater is used for make-up water for plant cooling. AES discharges the cycled water with lower suspended solids and biological oxygen demand than the effluent of the city wastewater treatment system.

3.2. Red Hills EcoPlex

A public-private partnership including the Mississippi Development Authority, Choctaw Economic Development, 4-County Electric Power Association and the Tennessee Valley Authority has broken ground on the Red Hills EcoPlex, a 137-acre planned industrial park that includes a recently commissioned 440 MW lignite-fired power station and an adjacent 700 MW combined-cycle, natural gas fired station currently under construction. The lignite for the 440 MW station comes from an adjoining open pit mine operated by a subsidiary of North American Coal Corporation. The project has received state financial commitments of $30 million for infrastructure and tax increment financing. An initial $1.4 million has been invested in basic infrastructure. Economic development officials are targeting the following industries for tenancy in the park: “food processing and kindred products, lumber and wood products, paper and allied products, stone, clay and concrete products, and other industries including carbon dioxide recovery, agricultural-based organic chemical products, fertilizer production, and textile milling”. The park is located in a very rural part of the state near Ackerman in Choctaw County which, at the time of groundbreaking, was experiencing a significant economic downturn and an 18% unemployment rate.

3.3. Alberta’s Industrial Heartland

Launched in 1999, Alberta’s Industrial Heartland was conceived by four municipalities in Alberta, Canada’s heartland to “ensure future growth in the region occurred in a coordinated and responsible manner.” The region is home to more than C$11 billion in industrial investment in the petrochemical and chemical industries. Integral to the initiative is the improvement of energy and material utilization within plant complexes and among plant complexes, for both economic gains and ecological improvement. The initiative seeks to brand the region as an ecologically-sensitive petrochemical industry cluster. Economic development opportunities are specifically sought in the area of downstream chemicals and cogeneration between existing firms and by recruiting new firms to the region. The initiative is actively promoted by regular “Synergy” workshops on various industry ecology topics, and via the Internet and paper literature. More about Alberta’s Industrial Heartland initiative is provided in the Appendix.

3.4. Northern Lights Ethanol

Northern Lights Ethanol is a 40 million gallon per year ethanol refinery sited adjacent to Big Stone I power station (owned by Otter Tail Power, Northwestern Public Service Co. and MDU).

Northern Growers Cooperative is the majority owner with ethanol developer Broin Companies as minority stakeholder. The 650 member farmer cooperative raised $14 million of start-up capital and Broin Companies helped finance the remainder. The refinery opened in 2002, and processes 15 million bushels of corn annually using process steam extracted from Big Stone. Steam is apparently sold at rates competitive with self generation. According to a recent Otter Tail Power financial report, steam sales to Northern Lights Ethanol totaled $500,000 in a three-month period in 2003. It’s unclear whether this is the total sum of steam sales for the period or simply Otter Tail Power Company’s share. The refinery benefits from a reduced capital outlay in equipment as well as limiting exposure to fuel price swings by switching from natural gas to coal-based steam. Both Northern Lights and Otter Tail Power benefit from other infrastructure and shared services including utilities, security, rail access and emergency services.

3.5. Sasol ChemCity

Sasol Limited, a South African corporation established in 1950, is a fuels and chemicals manufacturing conglomerate that converts low-grade coal to high-value products. The Sasol complex in South Africa consists of three facilities at two sites. Sasol Two and Sasol Three located in Sasolburg comprise the world's two largest gasification facilities[39]

Sasol and Genbel Securities (Gensec) formed a joint venture establishing ChemCity in the district of Sasolburg in 1998 to encourage the development of downstream SME chemical and related industry enterprises, particularly by disadvantaged black entrepreneurs. The aim has been to build a value-added chemicals industrial cluster that would use raw materials from Sasol's facilities, as an alternative to South Africa's annual import of chemical products worth billions of rand. ChemCity was worth R81 million in August 2001 with over 40 businesses occupying two units, owned by Sasol, Gensec and Real Africa Holdings. In 2002, Sasol's attempt to include Dow Chemical in ChemCity failed. Dow's participation would have doubled the value of ChemCity, as well as introduced the first chemical plants into the development. The ChemCity initiative was reintroduced in late 2004. Sasol Chemical Industries reestablished it as a wholly owned subsidiary. Sasol will assist in the identification and establishment of businesses and entrepreneurs by providing access and use of Sasol resources. Enterprises will carry the ChemCity brand.

ChemCity had three distinct advantages. The South African government backed the development. Sasol, a multi-billion dollar company, financed the initial phase, and the scale of Sasol's raw chemical production from its three facilities is extensive (at least five times more than the Great Plains Synfuels Plant). However, the component businesses within ChemCity are not known. From news reports, it appears that it lacked downstream chemical industries. The failure to obtain Dow's participation seems to have hindered its initial growth. No news was available subsequent to this event and Sasol executives were reluctant to discuss the matter.

3.6. Bruce Energy Centre

The Bruce Energy Centre in Tiverton, Ontario is based on the heat and infrastructure resources from the Bruce Nuclear generating facility. Six businesses have been recruited into the park based on the cost savings inherent in the shared-resources network. These businesses include a small-scale ethanol refinery, a livestock feeds company that dehydrates alfalfa, a fruit juice producer, a polypropylene plastic film producer, an 8-acre greenhouse complex, and an energy industry R&D facility. In addition to each company's use of the steam for process and building heating, there are other inter-company exchanges of materials like carbon dioxide from the (ethanol) alcohols refinery used by the greenhouse complex and dried distillers' grains used by the livestock feeds company. The Bruce Energy Centre has recently explored the deployment of a natural gas-fired cogeneration system to replace the nuclear plant as a source of the industrial park's steam.

Commercial Alcohols Inc.

3.7. Coffeyville

Coffeyville Refinery and Fertilizer Plant consists of a refinery that processes crude oil to produce petroleum products. Petroleum coke (petcoke), a major waste product of the process, is gasified to yield syngas which is used to produce ammonia. The refinery capacity is 125,000 BPD. A total of 1,100 short tons per day of petcoke is processed to produce 1,100 short tons per day of ammonia. A portion of ammonia and carbon dioxide are used to manufacture 1,500 short tons per day of Urea-Ammonia-Nitrate.

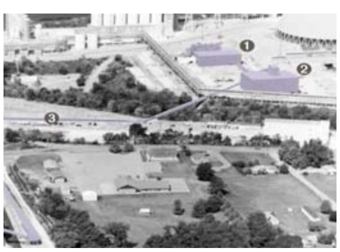
Coffeyville Refinery and Fertilizer Plant was formerly owned by Farmland Industries, Inc. The complex and other Farmland assets were sold to Coffeyville Resources, an affiliate of Connecticut-based private equity firm Pegasus Capital Advisors, in 2004 for $281 million. Farmland had lost $90 million in 2001, and was under pressure from the EPA after it failed to install best available control technologies (BACT) during a 1996 capacity expansion. This failure resulted in a Clean Air Act Notice of Violation in 2002. Pegasus typically holds its investment for two to five years on average, and could be looking for an opportunity to sell Coffeyville for a profit during better economic times.

Texaco Development Corporation was the main consultant and Black & Veatch Pritchard was the main contractor for the gasification and ammonia plants. Project evaluation started in 1996, and the project was completed in 2000. The gasifier was purchased from the Cool Water Integrated Gasification Combined Cycle facility owned by Southern California Edison. The ammonia technology is from Casale Inc. Financing of the project was achieved with minimum equity investment from Farmland, using a tax-exempt financing method Texaco had used for their El Dorado facility (180-ton per day coke gasification cogeneration plant) and Delaware City operation (a co-generation plant).

Coffevville Gasification Plant

The opportunity to dispose of petcoke waste for a profit, as well as to produce ammonia independent of natural gas price volatility was attractive for Farmlands. Capital costs were reduced by purchasing of old or idle plants, with minimum equity investment using a tax-exempt financing method. However, the long-term operation and profitability of the plant is uncertain due to its recent commissioning. The declaration of bankruptcy by Farmland Industries is not a direct result of the gasification and ammonia projects, but its weak financial status and EPA's enforcement action against their Coffeyville Refinery. In discussion to various experts, there was also suggestion that the rising price of ammonia fertilizers had contributed to their weak financial status.

3.8. First Energy Shippingport, PA



Aerial view of Bruce Mansfield plant and National Gypsum

Shippingport is similar to the ChemCity project in South Africa for the initiative and leadership by the primary industry player, in this case First Energy which owns and operates the Bruce Mansfield coal-fired power station in this Pennsylvania town. First Energy identified attractive candidates for recycling its flue gas desulfurization (FGD) byproduct and negotiated with North Carolina-based National Gypsum to site a gypsum sheetrock manufacturing plant adjacent to the power station. The 70-80 tons per hour recycling of gypsum is considered by some to be the largest single material recycling operation in North America. This networking alliance, along with commitments to recycled paper use and zero wastewater discharge, earned National Gypsum Company the 2002 Governor's Award for Environmental Excellence in Pennsylvania. The alliance also brought 100 jobs and $115 million new investment into the community ($30 million for recycling facility and $85 million for drywall plant).[40]

3.9. Laskin Energy Park

The 220-acre Laskin Energy Park is located in Hoyt Lakes, a rural community on the Iron Range of Northern Minnesota. The Park is a joint venture of Minnesota Power, the City of Hoyt Lakes, the Iron Range Resources and Rehabilitation Board, and the East Range Joint Powers Board. At the heart of the Park is the 110 MW Laskin Energy Center which markets low-cost electricity, steam and natural gas to tenants. Park management actively promotes its available resources for use by wood products manufacturing, metal fabrication, food processing, electronics, biotechnology firms Steam pressures of 50 psi saturated to 1,100 psi are offered to prospective customers. A new natural gas pipeline was installed in 2002 to market competitively price natural gas as well. In 2002 the park welcomed its first tenant, Belcorp Corporation (a non-metal die cutting operation) which relocated from the Twin Cities. Laskin Energy Center also speculatively built a 30,000 office-warehouse building in 2002 to be better positioned to market to the leased product. This facility is currently still available.

Aerial View of Laskin Energy Center

3.10. FlexCrete, Page, Arizona

The nation's largest recycler of coal combustion products, ISG Resources (now Headwaters Incorporated) and the Navajo Housing Authority chose Page, Arizona, for the site of one of the first major production facilities of FlexCrete, an aerated concrete block used in the construction industry. The block is composed of roughly 60 percent fly ash from coal-fired power stations. The Page, Arizona facility, opened in April 2005, is directly owned by the Navajo Housing Authority and is conveniently located on the border of the Navajo Nation utilizing fly ash from the nearby Salt River Project Navajo Power Plant. The Navajo Housing Authority has a share of ownership in the FlexCrete Technology through a joint venture with Headwaters Incorporated. The plant plans to serve the housing needs on the Navajo Nation as well as urban markets in Las Vegas and Phoenix. Internal market guarantees within the Navajo Housing Authority and flexible technology ownership by Headwaters appeared to drive the feasibility of this development project.


Tribal leaders tour FlexCrete plant

Figure 28: Summary of Benchmarked Projects

Project	Type	Notes & Lessons
Sasol ChemCity	Synfuels & chemicals complex	Designed to build and support entrepreneurial sector among South Africa's disadvantaged black population; challenges experienced in downstream chemicals small-business incubation; Sasol highly successful in internal products expansion
Red Hills Eco-Plex	Lignite power station, open pit mine & industrial park	Good pre-planning and financial commitment for infrastructure; currently lacking project champions; impact of poor general economic conditions made more severe by project's location
Alberta's Industrial Heartland	Regional chemical industry networking initiative	On-going economic development initiative spearheaded by several municipal government bodies; in-depth research and active database assists new development; strong industry and provincial government support
Laskin Energy Park	110 MW coal-fired power station and planned industrial park	A joint venture of Minnesota Power, the local municipality and two economic development organizations, this 220-acre industrial park in Minnesota's iron range has attracted a stamping and die-cutting operation and speculatively built a 30,000 industrial building
Northern Lights Ethanol	Ethanol refinery & power station	40 million gallon per year refinery sited adjacent to Big Stone 1 coal-fired power station, utilizing process steam; 650 member farmer cooperative raised $14 million of start-up capital; Broin Companies helped finance remainder
Londonderry Eco Park	Gas-fired power station & industrial park	720MW gas-fired power station built within existing industrial park; limited opportunity for resource-based economic development but effective branding and other marketing practices has landed new businesses
First Energy Shippingport	Coal-fired power station & gypsum wallboard manufacturer	Importance of industry as a champion; First Energy directly recruited National Gypsum and invested $30 million in fly ash separation and oxidation processes; importance of market proximity; 150 new jobs also brought support of local government
Bruce Energy Centre	Coal-fired power station & industrial park	Nuclear power plant provides steam, electricity, water, and sewage treatment to greenhouse, food processor, and alcohol and plastics producers; considering gas-fired cogeneration plant to supplement heat/electricity demand
Intervale Enterprise Center	Wood-fired power station & value added agricultural industries	Power plant operator is supportive but non-profit project champion is undercapitalized; still attempting to raise sufficient equity balance
FlexCrete	Manufacturer of aerated concrete bloc from CCP	First FlexCrete plant built in Page, Arizona by nation's largest manager of CCP; customer guarantees from Navajo Nation; proximity to other large urban markets considered important
Hortitherm Greenhouse Park	Greenhouses & coal-fired power plant	10+ acre greenhouse complex achieves economies of scale with capital investment in piping and water-to-air heat exchangers; 2.3 GW Neideraußen's cooling water is hotter than ND plants

3.12. Critical success factors

Based on an evaluation of resource synergy-based industrial development in the United States in the last decade, and interviews with national and international project leaders and other stakeholders, the following characteristics are considered crucial to a lasting successful development project:

- Dedicated, credible, and capable project champion/s
- Combination of visionaries (big picture project marketers) and "actionaries" (detail oriented staff who interpret the vision and get the work done)
- Leveraging existing industry, institutions, and/or other local resources
- Targeted business recruitment and an aggressive strategic marketing effort
- Strong relationships between industry and the development community and local government
- Project marketing emphasizes financial gains to project stakeholders
- Community is treated as a key partner throughout the planning and development process
- Small successes are focused on, achieved and celebrated, while maintaining a more comprehensive and challenging long-term vision, and
- Flexibility and willingness to adapt

3.13. Common errors

An examination of the benchmarking cases, including an analysis of numerous initiatives not described above, reveals a number of common errors and reasons for project stagnation or failure. Most of the errors that have been made by aspiring development practitioners are the converse of the success factors just described, for example, no dedicated project champion, scattered marketing effort, poor relationships with industry or local government, and little understanding of economic benefits. There are, however, other mistakes that are commonly made. These include:

- Disconnect with standard real estate development practices; for example, poor location and/or poor general economic conditions can doom or at best stall any project
- Reliance on quantitative software models (for by-product exchanges) to determine industry recruitment targets, rather than conventional marketing and sales strategies and relationship building, and
- Developers are only loosely aware of project benefits and do not attempt a quantification of financial returns and other benefits

4. Industrial Development Concepts

4.1. Concepts Considered

The project team evaluated a wide range of industries with a high relative demand for one or more of the energy, material, or other resources available within Coal Country. Our primary emphasis was on those industries with high energy inputs that could be served by either steam or hot water available at Coal Country's energy facilities such as greenhouses and aquaculture, and biofuel refineries. We also considered industries that utilize the various byproducts of coal gasification, as well as the opportunity to increase the local production of nitrogen-based fertilizers (an existing local product). In addition, we evaluated industries that have experience recycling the major solid material discharge of the plants: coal combustion products. Finally we considered the gross feasibility of coal liquefaction, a business development opportunity that would directly consume lignite as a primary feedstock. The following are summaries of the most promising industries and a discussion of their relative compatibility with the resources of Coal Country. Some of the main industries considered are further listed below. These include greenhouses, specialty chemicals and coal liquefaction.

4.2. Commercial Greenhouses

Commercial greenhouses have a history of co-location and collaboration with coal-fired power plants, and are a natural consideration for Coal Country. By definition, greenhouses require relatively stable climatic parameters of temperature and humidity, and often have significant heating demands outside the summer months. The hot water and steam available at Coal Country's power stations and gasification plant could provide a low-cost input for these greenhouses. Highly scaleable in terms of size, greenhouses could be developed as small operations (≤1 acre) or as 5-10 acre and larger complexes. Larger operations could benefit from diluting the initial capital costs of energy delivery infrastructure.

The greenhouse industry (which includes vegetables and herbs, cut flowers, bedding, potted, plants and ornamental plants, and tree seedlings) has expanded dramatically over the past decade, particularly in North America. For example, food-based greenhouse acreage grew sevenfold between 1994 and 2003, as consumer appetite surged for year-round availability of tomatoes, cucumbers, peppers, and herbs (see Figure 28). Over the past several years, however, much of the growth in food-based greenhouse acreage has occurred in Mexico where low cost labor and mild winters are driving many producers to seek expansion opportunities. Interestingly, the most concentrated development of vegetable greenhouses in North America exists in Leamington, Ontario, where a number of conventional outdoor growers experimented in the late 1980's with small greenhouses to increase their growing seasons. During the 1990's this collection of growers expanded their greenhouse operations, developed marketing cooperatives, and the region has since become a greenhouse market and technology leader. The Ontario experience is particularly relevant for Coal Country because of the similarly cold winters and high heating demand. Closer to North Dakota, Manitoba also has a thriving greenhouse sector with nearly 245 commercial greenhouse operations as of 2001, primarily involved in the production of bedding plants.

The conventional success criteria for commercial greenhouse agriculture are low-cost inputs (labor, heat, water, electricity) and access to customers. These criteria along with availability of sunlight have been determining factors for locating operations. Coal Country is clearly challenged with respect to distance from major population centers, but the available labor, water, and most importantly low cost heat and electricity may be sufficient to develop a case for siting greenhouses next to the area's energy stations. Also, North Dakota, particularly the western portion of the state receives some of the highest average solar insolation (3 kWh/meter^2/day) of the northern third of the United States (see Figure 29).

Figure 29: Growth of North American Greenhouse Agriculture

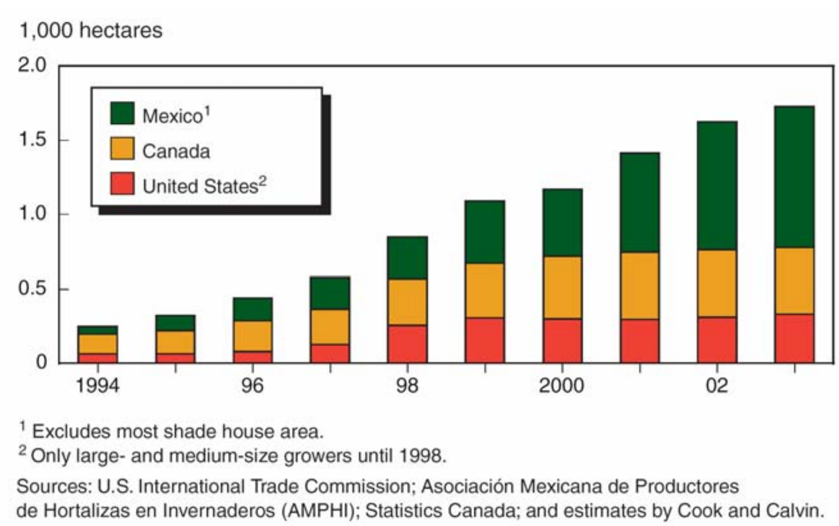
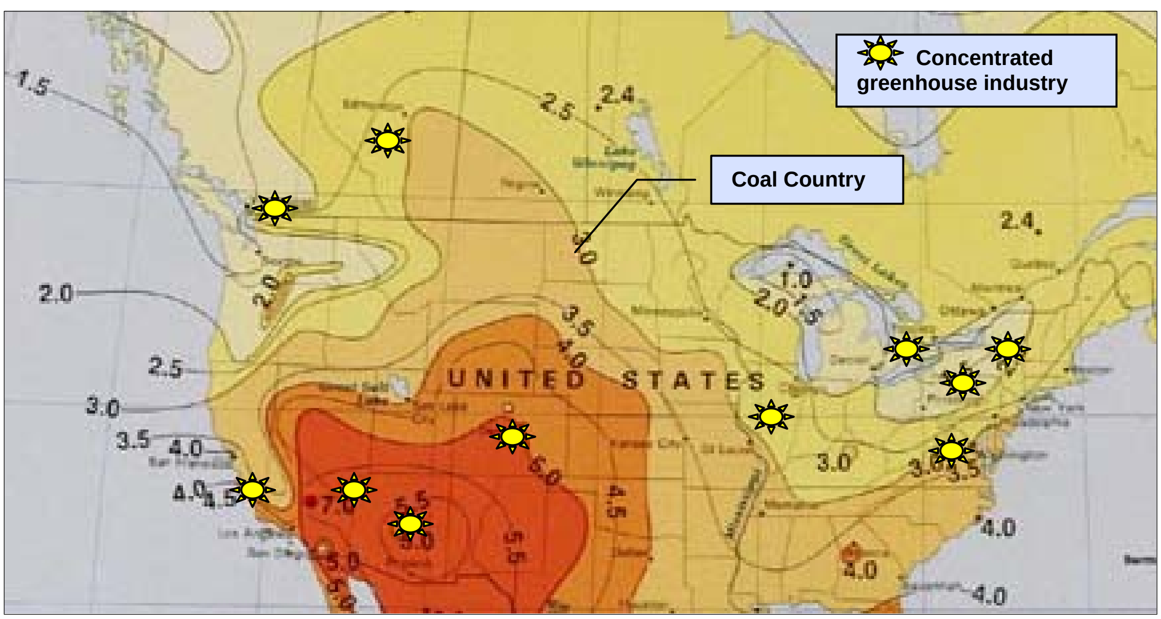


Figure 30: Average Solar Insolation for United States & Canada[41]



Examples of greenhouses heated by waste heat from power plants are commonplace. The 2.7 GW Niederaußen station in northern Germany has heated 13 acres of greenhouses since 1987.

With hot water temperatures that average 86ºF in the winter, a system of water-to-air heat exchangers maintains an indoor temperature of 72ºF even when outdoor air temperatures dip to 7ºF. A 10-acre greenhouse in Home City, Pennsylvania is also heated by the cooling-tower water of an adjacent power station.

A 1993 study prepared by the University of North Dakota estimated that the 374,000 gallon per minute cycle of hot water from Antelope Valley Station alone could heat 1,200 acres of greenhouses.[42] Employing similar assumptions, Coyote Station could support more than 500 acres and Leland Olds possibly even more. Stanton Station is the only generator without an adequate quality hot water resource. Dakota Gasification, which operates near capacity 24 hours per day, has a particularly valuable stable high temperature hot water discharge of 125,000 gallons per minute (averaging 95°F in the winter). The hot water discharges of AVS, Coyote, and Leland Olds vary in temperature with daily plant cycling. AVS data from 1988 show average ranges from 80°F to 110°F in the winter and from 85°F to 115°F in the summer (recent data was not available for this study). Coyote Station data from 2004 show narrower temperature ranges of 90°F to 105°F in the winter, 95°F to 110°F in the spring, and 100°F to 115°F in late summer (see Figure 30). Heat exchangers would be required with all of these prospective energy partners to convert the thermal resource, be it hot water or steam, for greenhouse space heating. In addition, greenhouse operations would require a back-up heating resource in the event of a plant shutdown. Fuel oil or propane would be the likely fuel sources for back-up heating.

Figure 31: Coyote Station Circulating Water Outlet Temperature, December 2004[43]

The following is a calculation of the estimated peak heating demand for a simple Quonset-style greenhouse located in Coal Country and the hot water or steam capacity required to meet that demand. The peak heat loss assumes a 90°F temperature differential (70°F inside temperature versus -20°F outside).

Figure 32: Greenhouse Peak Hot Water or Steam Demand

Quonset Style with Polyethylene Skin

Acres	Peak Heat Loss	GPM Water @ 75-115°	Steam @ 50 PSI
1	4,960,000 BTU/hr	300-500	5,000
10	49,600,000 BTU/hr	3,000-5,000	55,000
50	248,010,000 BTU/hr	15,000-25,000	270,000

In addition to heating resources, most of the energy plants of Coal Country have abundant land suitable for greenhouse development, though all the plants would require new infrastructure for delivery of hot water. Most of the energy plants could also divert limited quantities of Missouri River water for irrigation purposes. Limited potable water would also be available from Coyote Station and Great Plains Synfuels. Electrical and telecommunications services would be provided by the local respective utilities.

Another unique resource that could help attract greenhouse producers to Coal Country would be food-grade carbon dioxide, potentially available from Great Plains Synfuels. CO_2 supplementation (using compressed CO2 cylinders) has been shown to produce larger, higher quality plants, and can decrease the time from planting to resale. Dakota Gasification recently examined the feasibility of a 44/ton/day CO2 purification plant but found that high capital and transport costs and were not compatible with the market prices for food-grade CO_2 at this time. The feasibility of a much smaller capacity purification system, scaled to serve local greenhouses, has not yet been determined. It should also be noted that when the Great River Energy / Headwaters ethanol refinery becomes operational, another local source of CO_2 will be available to local greenhouse growers. Assuming an industry average of 18 pounds of CO_2 per bushel of corn processed, the Coal Creek Station plant could be expected to recover up to 440 tons of carbon dioxide per day.

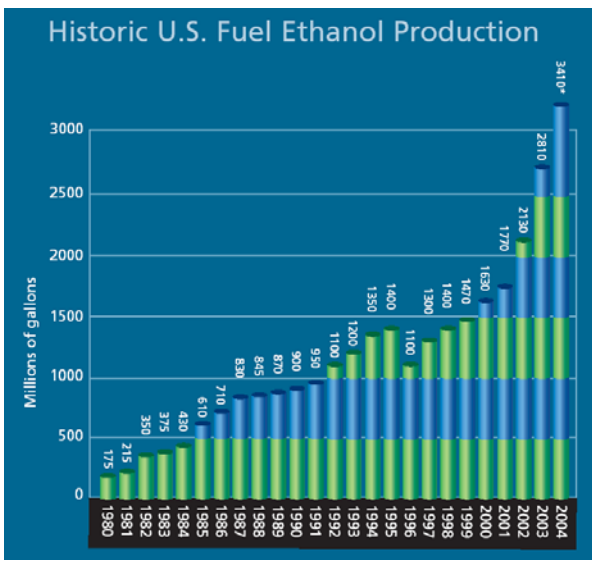
4.3. Biofuels

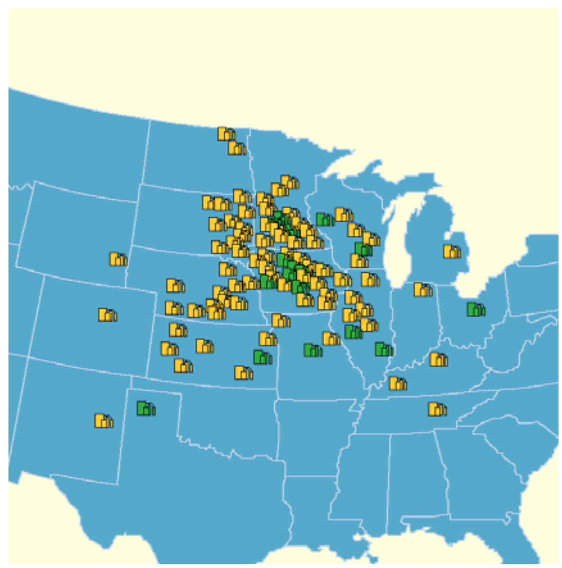
With an abundance of crop land, low cost sources of process energy and proximate customers for byproducts, Coal Country may offer strategic advantages for ethanol and biodiesel refining. Ethanol, with its high relative demand for process energy will likely be the more promising of the two. However, the industry standard feedstocks for both ethanol (corn) and biodiesel (soybeans) are grown outside the region, and would have to be railed in or substituted. Feasibility analyses must test whether the higher cost of transporting feedstock to Coal Country's energy facilities can be offset by the available energy savings. Regarding substitutes, the ethanol industry is already moving forward with wheat grain production (Manitoba and Saskatchewan) and is testing cellulosic feedstocks, both of which are widely available in Coal Country. The nascent US biodiesel industry is considering adopting the feedstock of their European counterparts - rapeseed (industrial canola) - and is also experimenting with mustard and other oilseeds. All are promising crops for cultivation in or near Coal Country.

4.3.1. Ethanol

US Fuel ethanol production and consumption has grown rapidly in the past several years, nearly doubling from 1,700 billion gallons in 2001 to 3,400 billion gallons in 2004. The federal Energy Bill signed into law by President Bush (August 2005) aims to double the current production levels to 7,500 billion gallons by 2012. With moderate corn prices during this period and increasing petroleum fuel prices, ethanol refineries have experienced significant increases in both revenue and profits. The average per gallon revenue rose from $1.20/gallon in 2001 to more than $1.90/gallon in 2004. Profits rose from less than $0.05/gallon to more than $0.40/gallon.

Figure 33: US Ethanol Production – Statistics and Plant Locations[44]

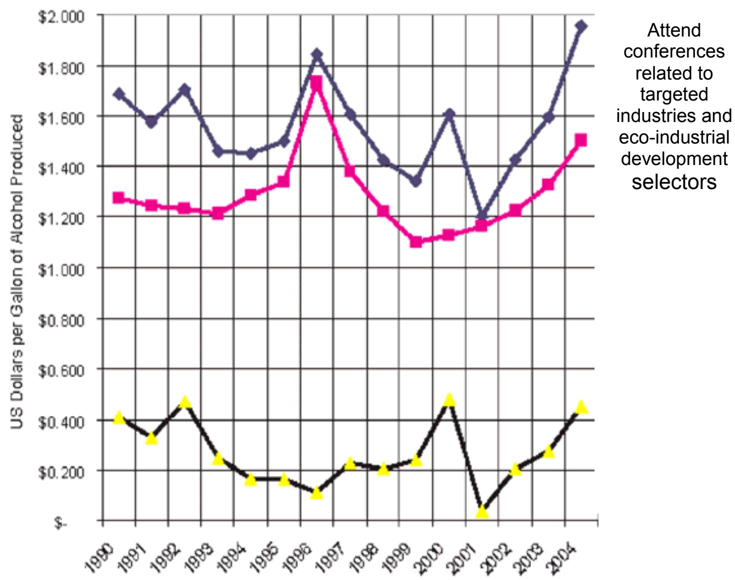




Ethanol refineries have long been leaders in the practice of byproducts utilization, recognizing the need to profit from the byproducts of the fermentation process. Dried distillers grains (DDGS) and liquid carbon dioxide are the primary byproducts from ethanol production, comprising 22% and 1.5%, respectively, of the average revenue for ethanol producers. Many researchers believe that future profitability gains for ethanol producers will be largely gained though developing higher-value products specifically from DDGS.[45] Animal feed comprises the bulk of current DDGS sales.

The production costs of corn-based ethanol are expected to remain relatively stable for the foreseeable future. According to the Energy Information Administration, significant cost efficiencies in ethanol refining can only be achieved through the substitution of carbohydrate (corn) feedstock with cellulosic feedstock. [46] Like corn ethanol, cellulosic ethanol (also known as bioethanol) is processed by converting the feedstock to a sugar and then fermenting it into alcohol. However, cellulose poses greater challenges during conversion to sugar, requiring the introduction of acids in a hydrolysis process. The Department of Energy is promoting biotechnology advances to reduce the cost of conversion of these low-cost feedstocks. Cellulosic ethanol holds the added promise of a higher net energy balance (energy contained within the fuel minus the energy used to produce): approximately 60,000 btu per gallon for cellulosic ethanol versus 20,000-25,000 btu for corn ethanol.

Figure 34: US Ethanol Industry: Revenues, Costs, Profits[47]



With the preponderance of agricultural land, cellulosic feedstocks in the vicinity of Coal Country are abundant. Among current resources, wheat straw is the most plentiful and immediately attractive. Studies have also shown that the region could also be a low cost grower of switchgrass (a purposely grown "energy crop").[48] Coal Country may also be particularly well suited for cellulosic ethanol because the production process is more energy (steam) intensive than corn ethanol, giving further value to a cogeneration relationship with the region's energy plants.

Figure 35: Prospective Location of Estimated Farmgate Prices for Switchgrass
(110,000 ton/year Facilities)

The compatibility of ethanol refineries and Coal Country's energy plants can be assessed by comparing a modern refinery's energy demand to the "waste heat" availability of the energy plants. After biomass feedstock (generally grain corn), energy is the second highest operating cost for an ethanol refinery. Ethanol refineries are large users of both process steam and electricity. Approximately 19-22 pounds steam and 0.9-2.0 kWh of electricity are required to produce a gallon of ethanol. Steam (and hot air) is used for liquefaction, fermentation, distillation, and the drying of byproducts. Operating 24 hours a day and seven days a week, a modern 50 million gallon per year (gpy) plant would require roughly 114,000 lbs/hr steam and 5.5 MW baseload of electricity. The 50 million gpy plant would expect to consume 963 million pounds of boiler steam (1.2 million mmBtu of fuel) and 48,000 MWh of electricity.[49] According the data provided to the project team by plant managers, it appears Coyote Station, Leland Olds and the gasification plant could supply the steam load necessary to operate this modern 50 million gallon per year plant. The electric load could either be serviced by Oliver Mercer Cooperative or MDU, directly by the power station, or depending on the availability of steam could be self-generated by the refinery with a small steam turbine.

Figure 36: Thermal and Electric Energy for Ethanol Production (2002 Survey)[50]

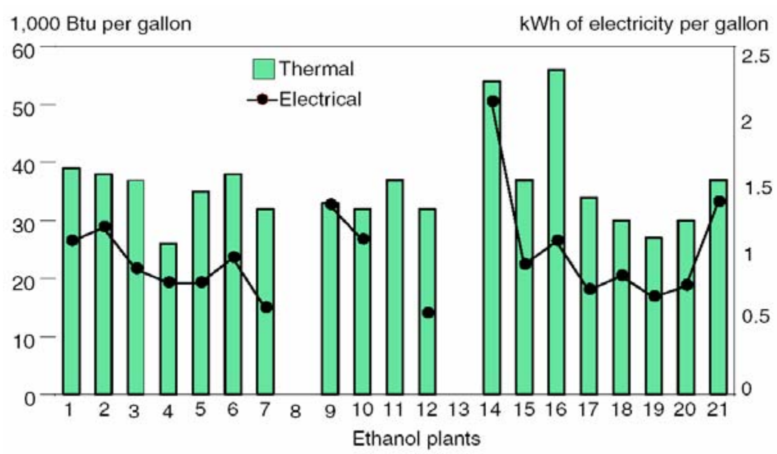


Figure 37: 2003 Coal Combustion Products (CCP) Production and Use Survey[51]

	Fly Ash	Bottom Ash	FGD Gypsum	FGD Wet Scrubbers	Boiler Slag	FGD Dry Scrubbers	FGD Other	FBC Ash*
CCP Production Category Totals**	70,150,000	18,100,000	11,900,000	17,350,000	1,836,235	1,444,273	167,345	796,718
CCP Production Totals								121,744,571
CCP Used Category Totals***	27,136,524	8,247,273	8,299,060	484,412	1,756,004	197,509	0	263,623
All CCP Used								46,384,405
CCP Use By Application****								
Concrete/Concrete Products /Grout	12,265,169	298,181	65,593		15,907	34,284		
Cement/ Raw Feed for Clinker	3,024,930	493,765	420,043		15,766	2,469		
Flowable Fill	136,618	20,327				9,184		
Structural Fills/Embankments	5,496,948	2,443,206		224,100	11,074	12,141		
Road Base/Sub-base/Pavement	493,487	1,138,101			29,800			
Soil Modification/Stabilization	515,552	67,998		704		114		188,708
Mineral Filler in Asphalt	52,608	0			31,402			
Snow and Ice Control	1,928	683,556			102,700			
Blasting Grit/Roofing Granules	0	42,604			1,455,140			
Mining Applications	683925	1,184,927		259,608	59,800	130,723		11,049
Wallboard	0	0	7,780,906					
Waste Stabilization/Solidification	3919898	30,508						49,217
Agriculture	12140	3,534	32,518			2,295		
Aggregate	137171	512,769			31,600	6,299		
Miscellaneous/Other	396150	1,327,797			2,815			14,649
CCP Category Use Totals	27136524	8,247,273	8,299,060	484,412	1,756,004	197,509		263,623
Application Use To Production Rate	38.68	45.57%	69.74%	2.79%	95.63%	13.68%		33.09%
Overall CCP Utilization Rate								38.10%

* As submitted based on 60 percent coal burn.

** CCP Production totals for Fly Ash, Bottom Ash, FGD Gypsum, and Wet FGD are extrapolated estimates rounded off to nearest 50,000 tons.

*** CCP Used totals for Fly Ash, Bottom Ash, FGD Gypsum, and Wet FGD are per extrapolation calculations (not rounded off).

**** CCP Uses by application for Fly Ash, Bottom Ash, FGD Gypsum, and Wet FGD are calculated per proportioning the CCP Used Category Totals by the same percentage as each of the individual application types' raw data contributions to the as-submitted raw data submittal total (not rounded off).

4.3. Specialty Chemicals

The Great Plains Synfuels Plant (GPSP) coal gasification process produces synthesis gas (syngas), a valuable gaseous feedstock mixture comprised primarily of hydrogen and carbon monoxide, with carbon dioxide, methane and other gases present in low percentages. Using the Fischer-Tropsch process, a wide variety of valuable chemicals (commonly called Fischer-Tropsch or FT liquids) can be produced from synthesis gas including substitute natural gas, fertilizers, noble gases, and many other chemicals critical to the building products, pesticide, and oil industries. At Great Plains Synfuels Plant, substitute natural gas and ammonia are the main products from the synthesis gas.

GPSP also produces ammonium sulfate, phenol, cresylic acid, liquid nitrogen, carbon dioxide, naphtha, methanol and krypton-xenon, which are by-products of the gasification and air separation processes. However, the operations lack the scale and synergistic co-location of refineries of other chemical products. For example, the volume produced for phenol and naphtha represents only 5%~10% of that of large facilities. As a comparison, Sasol's gasification facilities in South Africa produce over 80 million cubic meters per day while Dakota Gasification's produces less than 14 million cubic meters per day. While GPSP remains the largest coal gasification operation in North America, its output does not appear large enough to attract a refinery or other specialty chemical plant to its site.

In view of other more promising opportunities highlighted in this document and the limited manpower available to conduct business development, Dakota Gasification is wise to continue its strategy of bulk chemical sales rather than on-site business development. However, the possibility of creating an on-site down-stream chemical industry (i.e. businesses that will use the chemical products to create other value-added products locally) may be an attractive proposition in the future.

It is possible that the supply of chemical feedstocks from gasification in the area will increase if other local plants are repowered as integrated-gasification combined cycle (IGCC) plants. Under the Vision 21 program, U.S. DOE is pursuing coal gasification as one of the most promising technologies to increase the economic value of coal and to serve as a proactive response to future environmental regulation. One version of the coal gasification plant is a combined electricity generation, chemical and fuel production facility. The potential re-powering of Basin Electric's Leland Olds Unit 1 coal burner as an IGCC facility could be a signal for the eventual conversion of more coal power plants to coal gasification plants. This may lead to the formation of a larger local network of chemical production that could attract a down-stream chemical industry to the area in the next 20 years.

Figure 38: International Gasification Database

Plant Owner	Country	Plant Name	Tech Name	Proj Reality	Gasifier Status	Yr Start	Gasifiers	SGCap Nm3d	Cal MWEq	MWth In	MWth Out	Feed Class	Feed String	Prod Cat	Prod String
(Pty.) Ltd./Sasol Ltd.	South Africa	Sasol-II Syngas Plant	Lurgi Dry Ash	Active-Real	Operating	1977	40	37,224,000	2,778.80	5435	5090	Coal	Bit. coal	FT liquids	FT liquids
Sasol Chemical Industries (Pty.) Ltd./Sasol Ltd.	South Africa	Sasol-III Syngas Plant	Lurgi Dry Ash	Active-Real	Operating	1982	40	37,224,000	2,778.80	5435	5090	Coal	Bit. coal	FT liquids	FT liquids
Unspecified Owner	United States	Unspecified Plant	Texaco	Planning	Engineering	2006	5	20,200,000	1,508.00	3682	2761	Coal	Coal	Power	Electricity
Port of Port Arthur/Sabine Power I, Ltd.	United States	Port Arthur GCC Project	E-GAS (Destec/Dow)	Planning	Development	2005	3	14,850,000	1,108.60	2537	2029	Petcoke	Petcoke	Power	Electricity
Dakota Gasification Co.	United States	Great Plains Synfuels Plant	Lurgi Dry Ash	Active-Real	Operating	1984	14	13,900,000	1,037.70	1861	1900	Coal	Lignite & Ref. residue	Gaseous fuels	SNG & CO2
Petronor (RepsolYPF)/Iberdrola (PIEMSA)	Spain	Bilbao IGCC Plant	Texaco	Planning	Engineering	2005	2	12,100,000	903.3	2017	1654	Petroleum	Vac. residue	Power	Electricity & H2
TECO Power Services Corp./Citgo/Texaco	United States	Lake Charles IGCC Project	Texaco	Planning	Engineering	2005	2	10,290,000	768.2	1876	1407	Petcoke	Petcoke	Power	Electricity, H2 & Steam
Eagle Energy (TECO Power Services/Texaco)	United States	Polk County Gasification Plant	Texaco	Planning	Engineering	2005	2	10,000,000	746.5	1823	1367	Petcoke	Petcoke	Power	Electricity
Shell Deer Park Refining Co.	United States	Deer Park GCC Plant	Texaco	Planning	Development	2006	2	9,377,500	700	1830	1400	Petcoke	Petcoke	Power	Electricity, Syngas & Steam
SARLUX srl	Italy	SARLUX GCC/H2 Plant	Texaco	Active-Real	Operating	2001	3	8,900,000	664.4	1484	1217	Petroleum	Visbreaker residue	Power	Electricity, H2 & Steam
Dong Ting	China	Hunan Syngas Plant	Texaco	Planning	Development	2006	2	8,564,750	639.4	1561	1171	Coal	Coal	Chemicals	Syngas
Project IGCC Normandie (TotalFinaElf/EdF/Texac	France	Normandie IGCC Plant	Texaco	Planning	Engineering	2005	3	7,600,000	567.4	1272	1043	Petroleum	Fuel oil	Power	Electricity, Steam & H2
Shell MDS (Malaysia) Sdn. Bhd.	Malaysia	Bintulu GTL Plant	Shell	Active-Real	Operating	1993	6	7,552,000	563.8	1215	1032	Gas	Natural gas	FT liquids	Mid-distillates
Global Energy, Inc.	United States	Kentucky Pioneer Energy AFT-IGCC Plant	BGL	Planning	Development	2003	1	7,357,000	549.2	910	727	Coal	Coal & MSW	Power	Electricity & Diesel
Global Energy, Inc.	United States	Lima Energy IGCC Plant	BGL	Planning	Development	2003	1	7,357,000	549.2	910	727	Coal	Coal & MSW	Power	Electricity & H2
Mitteldeutsche ErdölRaffinerie GmbH	Germany	Leuna Methanol Anlage	Shell	Active-Real	Operating	1985	6	7,200,000	537.5	1163	984	Petroleum	Visbreaker residue	Chemicals	H2, Methanol & Electricity
ISAB Energy	Italy	ISAB/Mission Energy IGCC Project	Texaco	Active-Real	Operating	2000	2	7,181,000	536.1	1230	982	Petroleum	ROSE asphalt	Power	Electricity, H2 & Steam
Sasol Chemical Industries (Pty.) Ltd./Sasol Ltd.	South Africa	Sasol-I F-T Syngas Plant	Lurgi Dry Ash	Active-Real	Operating	1955	17	7,100,000	530	1169	971	Coal	Bit. coal	FT liquids	FT liquids
Sinopec/Shell	China	Caojing Power Plant	Shell	Planning	Development	2004	2	7,000,000	522.6	1196	957	Coal	Coal	Power	Electricity & Syngas
ATI Sulcis	Italy	Sulcis IGCC Project	Shell	Planning	Development	2004	2	7,000,000	522.6	1196	957	Coal	Coal	Power	Electricity
Indian Oil Corp. Ltd.	Inda	Paradip Gasification H2/Power Plant	Shell	Planning	Development	2003	3	6,500,000	485.2	1111	889	Petcoke	Petcoke	Chemicals	H2 & Electricity
Global Energy, Inc.	Germany	Schwarze Pumpe Town Gas Plant	Lurgi Dry Ash	Active-Real	Operating	1964	7	6,205,000	463.2	1113	848	Biomass/ Waste	Municipal waste	Power	Electricity & Methanol
Nippon Petroleum Refining Co.	Japan	Yokohama Cogen/B	Texaco	Active-Real	Construction	2003	2	5,800,000	433	967	793	Petroleum	Vac. residue	Power	Electricity
Sokolovska Uhelna, A.S.	Czech Republic	Vrecopower/Vresova IGCC Project	HTW	Planning	Development	2003	2	5,760,000	430	984	787	Coal	Lignite	Power	Electricity
Global Energy, Inc./Fife Electric	United Kingdom	Fife Electric	BGL	Planning	Development	2002	1	5,358,000	400	852	733	Coal	Coal & sludge	Power	Electricity
Millenium (Quantum)	United States	LaPorte Syngas Plant	Texaco	Active-Real	Operating	1979	2	4,800,000	358.3	772	656	Gas	Natural gas	Chemicals	Methanol & CO
Hindustan Petroleum Corp. Ltd.	India	Bhatinda IGCC	Texaco	Planning	Development	2005	2	4,750,000	354.6			Petcoke	Petcoke	Power	Electricity
Hydro Agri Brunsbüttel	Germany	Brunsbüttel	Ammonia Plant Shell	Active-Real	Operating	1978	4	4,700,000	350.9	803	643	Petroleum	Hvy vis. residue	Chemicals	Ammonia
Sokolovska Uhelna, A.S.	Czech Republic	Vresova IGCC Plant	Lurgi Dry Ash	Active-Real	Operating	1996	26	4,700,000	350.9	796	636	Coal	Lignite	Power	Electricity & Steam
Shell Nederland Raffinaderij BV	Netherlands	Pernis Shell Gasification Hydrogen Plant	Shell	Active-Real	Operating	1997	3	4,662,200	348	800	637	Petroleum	Visbreaker residue	Chemicals	H2 & Electricity
Global Energy, Inc.	United States	Wabash River Energy Ltd.	E-GAS (Destec/Dow)	Active-Real	Operating	1995	2	4,320,000	322.5	738	591	Petcoke	Petcoke	Power	Electricity
VEBA Chemie AG	Germany	Gelsenkirchen Ammonia/Methanol Plant	Shell	Active-Real	Operating	1973	4	4,300,000	321	717	588	Petroleum	Vac. residue	Chemicals	Ammonia & Methanol
Elcogas SA	Spain	Puertollano GCC Plant	PRENFLO	Active-Real	Operating	1997	1	4,300,000	321	735	588	Coal	Coal & petcoke	Power	Electricity
Unspecified Utility Consortium	Japan	Unspecified IGCC Plant	ICGRA	Planning	Development	2004	1	4,282,000	319.7	781	585	Coal	Coal	Power	Electricity
Motiva Enterprises LLC	United States	Delaware Clean Energy Cogeneration Proje	Texaco	Active-Real	Operating	2001	2	3,800,000	283.7	693	520	Petcoke	Fluid petcoke	Power	Electricity & Steam
api Energia S.p.A.	Italy	api Energia S.p.A. IGCC Plant	Texaco	Active-Real	Operating	2001	2	3,630,000	271	605	496	Petroleum	Visbreaker residue	Power	Electricity & Steam
Chemopetrol a.s.	Czech Republic	Most Gasification Plant	Shell	Active-Real	Operating	1971	6	3,600,000	268.7	600	492	Petroleum	Vac. residue	Chemicals	Methanol & Ammonia
Sinopec/Shell	China	Anhui Ammonia Plant	Shell	Planning	Development	2004	2	3,500,000	261.3	598	479	Coal	Coal	Chemicals	Ammonia
Unspecified owner	Unspecified Eur. c	Unspecified Plant	Shell	Planning	Development	2005	2	3,500,000	261.3	584	479	Petroleum	Residue	Power	Electricity
Sinopec/Shell	China	Hubei Ammonia Plant	Shell	Planning	Development	2004	2	3,500,000	261.3	598	466	Coal	Coal	Chemicals	Ammonia
Sinopec/Shell	China	Dong Ting Ammonia Plant	Shell	Planning	Development	2003	1	3,410,000	254.6	583	466	Coal	Coal	Chemicals	Ammonia
Demkolec BV	Netherlands	Buggenum IGCC Plant	Shell	Active-Real	Operating	1994	1	3,408,000	254.4	703	466	Coal	Bit. coal	Power	Electricity
AGIP Raffinazione S.p.A.	Italy	Agip IGCC	Shell	Planning	Development	2003	2	3,340,000	249.3	557	457	Petroleum	Visbreaker residue	Power	Electricity & H2
Ultrafertil S.A.	Brazil	Araucária Ammonia Plant	Shell	Active-Real	Operating	1979	3	3,300,000	246.4	550	451	Petroleum	Asphalt residue	Chemicals	Ammonia
Tampa Electric Co.	United States	Polk County IGCC Project	Texaco	Active-Real	Operating	1996	1	3,300,000	246.4	602	451	Coal	Coal	Power	Electricity
Shanghai Pacific Chemical Corp.	China	Gas Plant No. 2	GTI (IGT) U-GAS	Active-Real	Operating	1994	8	3,000,000	224	513	410	Coal	Bit. coal	Gaseous fuels	Fuel gas & Town gas
Waste Management & Processors, Inc.	United States	Gilberton Culm-to-Clean Fuels Plant	Texaco	Planning	Development	2004	2	3,000,000	224	547	410	Coal	Ant. culm	FT liquids	Diesel & Electricity
Agip Raffinazione S.p.A.	Italy	Sannazzaro GCC Plant	Texaco	Planning	Development	2005	2	3,000,000	224	511	409	Petroleum	Visbreaker residue	Power	Electricity
Sierra Pacific Power Co.	United States	Piñon Pine IGCC Power Project	KRW	Active-Real	Operating	1998	1	2,973,000	221.9	236	167	Coal	Bit. coal	Power	Electricity
Gujarat National Fertilizer Co.	India	Narmanda Ammonia/Methanol Plant	Texaco	Active-Real	Operating	1982	3	2,964,600	221.3	507	405	Petroleum	Ref. residue	Chemicals	Ammonia & Methanol
Esso Singapore Pty. Ltd.	Singapore	Chawan IGCC Plant	Texaco	Active-Real	Operating	2001	2	2,660,000	198.6	450	364	Petroleum	Residual oil	Power	Electricity, H2 & Steam
ExxonMobil	United States	Baytown Syngas Plant	Texaco	Active-Real	Operating	2000	2	2,540,000	189.6	423	347	Petroleum	Deasphalter pitch	Gaseous fuels	Syngas
BASF AG	Germany	Ludwigshafen Methanol Plant	Texaco	Active-Real	Operating	1974	4	2,500,000	186.6	417	342	Petroleum	Vac. residue & heavy f	Chemicals	Methanol
China National Petrochemical	China	Ningxia Syngas Plant	Texaco	Active-Real	Operating	1988	3	2,500,000	186.6	417	342	Petroleum	Visbreaker residue	Gaseous fuels	Gases
Quimigal Adubos	Portugal	Barreiro Ammonia Plant	Shell	Active-Real	Operating	1984	2	2,400,000	179.2	400	328	Petroleum	Vac. residue	Chemicals	Ammonia
China National Technology Import Co.	China	Shaanxi Ammonia Plant	Lurgi Dry Ash	Active-Real	Operating	1987	4	2,282,492	170.4	367	312	Coal	Anthracite	Chemicals	Ammonia
Henan	China	Puyang Ammonia Plant	Lurgi Dry Ash	Active-Real	Operating	2000	4	2,282,492	170.4	367	312	Coal	Anthracite	Chemicals	Ammonia
Rheinbraun	Germany	Ville Methanol Plant	Texaco	Active-Real	Operating	1985	3	2,231,500	166.6	381	305	Coal	Coal	Chemicals	Methanol
Ube Ammonia Industry Co. Ltd.	Japan	Ube City Ammonia Plant	Texaco	Active-Real	Operating	1984	4	2,150,000	160.5	392	294	Coal	Coal & petcoke	Chemicals	Ammonia
Chinese Petroleum Corp.	Taiwan	Kaohsuing Syngas Plant	Texaco	Active-Real	Operating	1984	2	2,143,000	160	391	293	Petroleum	Bitumen	Chemicals	H2, CO & Methanol SG
Farmland Industries, Inc.	United States	Coffeyville Syngas Plant	Texaco	Active-Real	Operating	2000	1	2,141,200	159.8	390	293	Petcoke	Petcoke	Chemicals	Ammonia & UAN
Hoechst Celanese	United States	Houston Oxochemicals Plant	Shell	Active-Real	Operating	1977	3	2,100,000	156.8	338	287	Gas	Natural gas	Chemicals	Oxochemicals
Fertilizer Corp. of India Ltd.	India	Sindri Ammonia Plant	Shell	Active-Real	Operating	1977	3	2,100,000	156.8	350	287	Petroleum	Heavy fuel oil	Chemicals	Ammonia
Hindustan Fertilizer Corp. Ltd.	India	Haldia Ammonia/Methanol Plant	Shell	Active-Real	Operating	1978	3	2,100,000	156.8	350	287	Petroleum	Bunker C fuel oil	Chemicals	Ammonia & Methanol
Fertilizer Corp. of India Ltd.	India	Nangal Ammonia Plant	Shell	Active-Real	Operating	1978	3	2,100,000	156.8	350	287	Petroleum	Bunker C fuel oil	Chemicals	Ammonia
National Fertilizer Ltd.	India	Panipat Ammonia Plant	Shell	Active-Real	Operating	1978	3	2,100,000	156.8	350	287	Petroleum	Bunker C fuel oil	Chemicals	Ammonia
National Fertilizer Ltd.	India	Bathinda Ammonia Plant	Shell	Active-Real	Operating	1979	3	2,100,000	156.8	350	287	Petroleum	Bunker C fuel oil	Chemicals	Ammonia
Zhenhai Refining & Chemical Co.	China	Zhenhai Ammonia Plant	Texaco	Active-Real	Operating	1983	3	2,100,000	156.8	350	287	Petroleum	Visbreaker residue	Chemicals	Ammonia
Inner Mongolia Fertilizer Co.	China	Hohhot Ammonia Plant	Shell	Active-Real	Operating	1996	2	2,100,000	156.8	326	287	Petroleum	Vac. residue	Chemicals	Ammonia
Juijiang Petrochemical Co.	China	Juijiang Ammonia Plant	Shell	Active-Real	Operating	1996	2	2,100,000	156.8	326	287	Petroleum	Vac. residue	Chemicals	Ammonia
Lanzhou Chemical Industrial Co.	China	Lanzhou Ammonia Plant	Shell	Active-Real	Operating	1998	2	2,100,000	156.8	350	287	Petroleum	Vac. residue	Chemicals	Ammonia
Koa Oil Co. Ltd.	Japan	Marifu IGCC Plant	Texaco	Planning	Development	2004	2	2,100,000	156.8	350	287	Petcoke	Petcoke	Power	Electricity
China National Petrochemical	China	Urumqi Ammonia Plant	Texaco	Active-Real	Operating	1985	3	2,100,000	156.8	358	287	Petroleum	Visbreaker residue	Chemicals	Ammonia
Beijing Coking	China	Beijing Methanol Plant	Texaco	Planning	Development	2006	1	2,100,000	156.8	358	287	Petroleum	Fuel oil	Chemicals	Methanol
Dalian Chemical Industrial Corp.	China	Dalian Ammonia Plant	Texaco	Active-Real	Operating	1995	2	2,096,500	156.5	358	287	Petroleum	Visbreaker residue	Chemicals	Ammonia
Nanjing Chemical Industry Co.	China	Nanjing Ammonia Plant	Texaco	Active-Real	Operating	2000	2	2,096,500	156.5	358	287	Petroleum	Eureka pitch	Chemicals	Ammonia
Jilin Chemical Industrial Corp.	China	Jilin Ammonia Plant	Texaco	Active-Real	Construction	2001	2	2,096,500	156.5	358	287	Petroleum	Visbreaker residue	Chemicals	Ammonia
Equilon Enterprises LLC	United States	Wilmington H2 Plant	Texaco	Active-Real	Operating	1967	2	2,050,000	153	342	280	Petroleum	Heavy fuel oil	Chemicals	H2
Weihe Fertilizer Co.	China	Shaanxi Ammonia Plant	Texaco	Active-Real	Operating	1996	3	2,040,000	152.3	372	279	Coal	Coal	Chemicals	Ammonia
Fertilizer Corp. of India Ltd.	India	Ramagundam Ammonia Plant	Koppers-Totzek	Active-Real	Operating	1979	3	2,000,000	149.3	342	273	Coal	Bit. coal	Chemicals	Ammonia
Fertilizer Corp. of India Ltd.	India	Talcher Ammonia Plant	Koppers-Totzek	Active-Real	Operating	1979	3	2,000,000	149.3	342	273	Coal	Bit. coal	Chemicals	Ammonia
T & P Syngas (Texaco/Praxair)	United States	Texas City Syngas Plant	Texaco	Active-Real	Operating	1996	1	1,920,000	143.3	348	278	Gas	Natural gas	Chemicals	H2 & CO

International Gasification Database (continued)

Plant Owner	Country	Plant Name	Tech Name	Proj Reality	Gasifier Status	Yr Start	Gasifiers	SGCap Nm3d	Cal MWEq	MWth In	MWth Out	Feed Class	Feed String	Prod Cat	Prod String
Motiva Enterprises LLC	United States	Convent H2 Plant	Texaco	Active-Real	Operating	1984	2	1,880,000	140.3	313	257	Petroleum	H-Oil bottoms	Chemicals	H2
Air Products & Chemicals, Inc.	United States	LaPorte Syngas Plant	Texaco	Active-Real	Operating	1996	2	1,850,000	138.1	316	253	Gas	Natural gas	Chemicals	H2 & CO
Global Energy, Inc./Fife Power	United Kingdom	Fife Power	BGL	Active-Real	Construction	2001	1	1,696,200	126.6	273	218	Coal	Coal & sludge	Power	Electricity
Singapore Syngas Pte. Ltd. (Texaco/Messer)	Singapore	Singapore Syngas Plant	Texaco	Active-Real	Operating	2000	2	1,610,000	120.2	268	220	Petroleum	Ref. residue	Chemicals	H2 & CO
Eastman Chemical Co.	United States	Kingsport Integrated Coal Gasification Facili	Texaco	Active-Real	Operating	1983	2	1,600,000	119.4	292	219	Coal	Bit. coal	Chemicals	Acetic anhydride & Methanol
Air Liquide America Corp.	United States	Longview Gasification Plant	Texaco	Active-Real	Construction	2002	2	1,558,000	116.3	251	213	Gas	Natural gas	Chemicals	Syngas & Steam
MSK-Radna	Yugoslavia	Methanol Plant	Texaco	Active-Real	Operating	1987	1	1,540,000	115	248	211	Gas	Natural gas	Chemicals	Methanol
Shanghai Pacific Chemical Corp.	China	Gas Plant No. 2	Texaco	Active-Real	Operating	1997	3	1,530,000	114.2	279	209	Coal	Anthracite	Chemicals	Methanol, Town gas & Acetic acid
Shougang Iron & Steel Co.	China	Beijing Town Gas Plant	Texaco	Active-Real	Operating	1995	3	1,500,000	112	274	205	Coal	Coal	Gaseous fuels	Town gas & Electricity
Unspecified owner	Germany	Methanol Plant	Texaco	Active-Real	Operating	1997	1	1,500,000	112	250	205	Petroleum	Visbreaker residue	Chemicals	Methanol
DEA Mineraloel AG	Germany	Wesseling Syngas Plant	Texaco	Active-Real	Operating	2000	1	1,500,000	112	250	205	Petroleum	Residual oil	Chemicals	Methanol
Global Energy, Inc.	Germany	Slurry/Oil Gasification	Lurgi MPG	Active-Real	Operating	1968	1	1,440,000	107.5	246	197	Petroleum	Oil & Slurry	Power	Electricity & Methanol
Falconbridge Dominicania	Dominican Repub	Santo Domingo Syngas Plant	Shell	Active-Real	Operating	1971	12	1,440,000	107.5	240	197	Petroleum	Bunker C fuel oil	Gaseous fuels	Reducing gas
Huainan General Chemical Works	China	Hefei City Ammonia Plant	Texaco	Active-Real	Operating	2000	3	1,400,000	104.5	255	191	Coal	Coal	Chemicals	Ammonia
DEA Mineraloel AG	Germany	Wesseling Methanol Plant-VI	Shell	Active-Real	Operating	1969	2	1,300,000	97	217	178	Petroleum	Heavy cracked residu	Chemicals	Methanol
SAR GmbH	Germany	SAR Plant-II	Texaco	Active-Real	Operating	1986	1	1,200,000	89.6	200	164	Petroleum	Vac. residue	Chemicals	Oxochemicals &H2
Global Energy, Inc.	Germany	Schwarze Pumpe Gasification Plant	GSP	Active-Real	Operating	1992	1	1,200,000	89.6	234	164	Biomass/ Waste	Municipal waste	Power	Electricity & Methanol
PRAOIL	Italy	Gela Ragusa H2 Plant	Texaco	Active-Real	Operating	1963	2	1,150,000	85.8	185	157	Gas	Natural gas	Chemicals	H2
Global Energy, Inc.	Germany	Schwarze Pumpe Power/Methanol Plant	BGL	Active-Real	Operating	1999	1	1,138,000	85	175	156	Biomass/ Waste	Household waste & Bi	Power	Electricity & Methanol
BASF AG	Germany	Ludwigshafen Oxochemicals Plant	Texaco	Active-Real	Operating	1966	1	1,000,000	74.7	167	137	Petroleum	Heavy fuel oil	Chemicals	Oxochemicals
BASF AG	Germany	Ludwigshafen H2 Plant	Texaco	Active-Real	Operating	1968	4	980,208	73.2	167	134	Petroleum	Fuel oil	Chemicals	H2
Celanese Chemical (Ruhrchemie)	Germany	Oxochemicals Plant	Texaco	Active-Real	Operating	1977	1	960,000	71.7	160	131	Petroleum	Heavy fuel oil & vac. r	Chemicals	Oxochemicals
BP Chemicals, Ltd.	United Kingdom	Hull Syngas Plant	Texaco	Active-Real	Operating	1989	1	910,900	68	147	125	Gas	Natural gas	Chemicals	Acetyls
Unspecified owner	United States	Oxochemicals Plant	Texaco	Active-Real	Operating	1983	2	830,000	62	134	114	Gas	Natural gas	Chemicals	Oxochemicals
BOC Gases	Australia	Brisbane H2 Plant	Texaco	Active-Real	Operating	2000	2	805,000	60.1	129	110	Gas	Natural gas & Ref. off-	Chemicals	H2
IBIL Energy Systems Ltd. (IES)	India	Sanghi IGCC Plant	GTI (IGT) U-GAS	Planning	Engineering	2002	1	804,000	60	136	109	Coal	Lignite	Power	Electricity & Steam
Neyveli Lignite Corp. Ltd.	India	Neyveli Syngas Plant	Shell	Active-Real	Operating	1979	2	800,000	59.7	133	109	Petroleum	Bunker C fuel oil	Chemicals	Syngas
Nitrogen Works of Societé el Nasr d' Engrois	Egypt	Suez Ammonia Plant	Koppers-Totzek	Active-Real	Operating	1966	3	778,000	58.1	125	106	Gas	Ref. off-gases	Chemicals	Ammonia
Boise Cascade Corp.	United States	Site not yet determined	GTI (IGT) U-GAS	Planning	Development	2004	1	750,000	56	128	103	Biomass/ Waste	Biomass	Power	Electricity
Rüdersdorfer Zement GmbH	Germany	Fuel Gas Plant	Lurgi CFB	Active-Real	Operating	1996	1	732,000	54.6	110	100	Biomass/ Waste	Biomass, Wastes & G	fuels	Fuel gas
Qilu Petrochemical Ind.	China	Zibu Methanol/Oxochemicals	Shell	Active-Real	Operating	1987	2	715,000	53.4	119	98	Petroleum	Vac. residue	Chemicals	Methanol & Oxochemicals
Praxair (EniChem)	Italy	Ravenna Syngas Plant	Texaco	Active-Real	Operating	1958	2	700,000	52.3	113	96	Gas	Natural gas	Chemicals	CO
Sociedade Portugusa de Petroquimica S.A.R.L.	Portugal	Lisbon Ammonia Plant	Texaco	Active-Real	Operating	1961	3	620,000	46.3	103	85	Petroleum	Naphtha	Chemicals	Ammonia
EPZ	Netherlands	Americentrale Fuel Gas Plant	Lurgi CFB	Active-Real	Operating	2000	1	614,300	45.9	105	84	Biomass/ Waste	Demolition wood	Power	Electricity
Air Products (ICI)	United Kingdom	Billingham Oxochemicals Plant	Texaco	Active-Real	Operating	1959	3	600,000	44.8	97	82	Gas	Natural gas	Chemicals	Oxochemicals
Mitsui	Japan	CO Plant	Texaco	Active-Real	Operating	1961	2	600,000	44.8	100	82	Petroleum	Crude oil	Chemicals	CO
Chemische Werke Hüls AG	Germany	Marl Oxochemicals Plant	Texaco	Active-Real	Operating	1967	1	600,000	44.8	100	82	Petroleum	Heavy fuel oil	Chemicals	Oxochemicals
Chemische Werke Hüls AG	Germany	Marl Oxochemicals Plant	Texaco	Active-Real	Operating	1969	1	600,000	44.8	100	82	Petroleum	Vac. residue & heavy f	Chemicals	Oxochemicals
Unspecified owner	France	Oxochemicals Plant	Texaco	Active-Real	Operating	1976	1	600,000	44.8	97	82	Gas	Natural gas	Chemicals	Oxochemicals
Unspecified owner	South Korea	CO Plant	Texaco	Active-Real	Operating	1997	1	600,000	44.8	100	82	Petroleum	Naphtha	Chemicals	CO
Oxochimie S.A.	France	Lavéra Syngas Plant	Texaco	Active-Real	Operating	1977	1	590,976	44.1	99	81	Gas	Natural gas	Chemicals	Oxochemicals
Calla Energy Partners, LLC	United States	Calla GCC Plant	GTI (IGT) U-GAS	Planning	Development	2003	1	590,000	44	101	81	Biomass/ Waste	Biomass	Power	Electricity
Exxon Chemical Co.	United States	Plant	Baton Rouge Oxochem	Active-Real	Operating	1978	3	570,000	42.6	95	78	Petroleum	Heavy fuel oil	Chemicals	Oxochemicals
Unspecified owner	Japan	Methanol Plant	Texaco	Active-Real	Operating	1982	2	550,000	41.1	92	75	Petroleum	Vac. residue	Chemicals	Methanol
Lu Nan Chemical Industry (Group) Co./CNTIC	China	Lu Nan Ammonia Plant	Texaco	Active-Real	Operating	1993	2	525,000	39.2	96	72	Coal	Bit. coal	Chemicals	Ammonia
Lucky Goldstar Chemical Ltd.	South Korea	Naju Ammonia Plant	Shell	Active-Real	Operating	1969	1	500,000	37.3	83	68	Petroleum	Bunker C fuel oil	Chemicals	Ammonia
Hoechst Celanese	United States	Oxochemicals Plant	Texaco	Active-Real	Operating	1979	2	500,000	37.3	83	68	Petroleum	Naphtha & fuel oil	Chemicals	Oxochemicals
Sistemas de Energia Renovavel	Brazil	Brazilian BIGCC Plant	TPS	Planning	Development	2003	1	500,000	37.3	86	68	Biomass/ Waste	Biomass	Power	Electricity
Unspecified owner	France	Oxochemicals Plant	Texaco	Active-Real	Operating	1963	1	450,000	33.6	72	62	Gas	Natural gas	Chemicals	Oxochemicals
Union Carbide Corp.	United States	Taft Syngas Plant	Texaco	Active-Real	Operating	1995	1	432,000	32.2	70	59	Gas	Natural gas	Chemicals	Oxochemicals
Mitsubishi Petrochemicals	Japan	Yokkaichi Syngas Plant	Shell	Active-Real	Operating	1961	2	400,000	29.9	67	55	Petroleum	Bunker C fuel oil	Chemicals	Syngas
Unspecified owner	United States	Oxochemicals Plant	Texaco	Active-Real	Operating	1983	1	400,000	29.9	64	55	Gas	Natural gas	Chemicals	Oxochemicals
Lucky Goldstar Chemical Ltd.	South Korea	Yochon Oxochemicals Plant	Shell	Active-Real	Operating	1996	1	384,000	28.7	64	53	Petroleum	Bunker C fuel oil	Chemicals	Oxochemicals
Lahden Lämpövoima Oy	Finland	Kymijärvi ACFBG Plant	FW ACFBG	Active-Real	Operating	1998	1	351,118	26.2	60	48	Biomass/ Waste	Biofuels	Power	Electricity & District heat
Unspecified owner	United States	Oxochemicals Plant	Texaco	Active-Real	Operating	1998	1	350,000	26.1	56	48	Gas	Natural gas	Chemicals	Oxochemicals
Netherlands Refining Co. BV	Netherlands	Europoort/Pernis IGCC Plant	Texaco	Planning	Development	2006	1	350,000	26.1	58	48	Biomass/ Waste	Waste plastics	Power	Electricity & CO
Beijing No. 4 Chemical	China	Beijing Oxochemicals Plant	Texaco	Active-Real	Operating	1995	1	320,000	23.9	53	44	Petroleum	Heavy oil	Chemicals	Oxochemicals
Kemira Chemicals Oy	Finland	Oulu Syngas Plant-I	Shell	Active-Real	Operating	1965	1	300,000	22.4	50	41	Petroleum	Bunker C fuel oil	Chemicals	Syngas
Air Liquide (RhonePoulenc)	France	Pont-de-Claix Syngas Plant	Texaco	Active-Real	Operating	1989	1	278,000	20.8	45	38	Gas	Natural gas	Chemicals	CO & H2
Air Liquide (Dow Stade GmbH)	Germany	Stade Syngas Plant	Texaco	Active-Real	Operating	1991	1	264,000	19.7	43	36	Gas	Natural gas	Chemicals	CO
Unspecified Owner	Germany	Fondotoce Gasification Plant	ThermoSelect	Active-Real	Operating	1999	3	250,000	18.7	43	34	Biomass/ Waste	MSW	Power	Electricity
Arbre Energy of Leeds	United Kingdom	Project ARBRE	TPS	Active-Real	Operating	2000	1	235,000	17.5	40	32	Biomass/ Waste	Biomass	Power	Electricity
Corenso United Oy Ltd.	Finland	Varkaus ACFBG Plant	FW ACFBG	Active-Real	Construction	2001	1	234,133	17.5	40	32	Biomass/ Waste	Packaging wastes	Gaseous fuels	Syngas
BASF plc	United Kingdom	Seal Sands Gasification Facility	Noell	Active-Real	Operating	2000	1	220,000	16.4	36	30	Biomass/ Waste	Toxic residue	Gaseous fuels	Syngas
China National Petrochemical	China	Daqing Oxochemicals Plant	Texaco	Active-Real	Operating	1986	1	210,000	15.7	35	29	Petroleum	Visbreaker residue	Chemicals	Oxochemicals
Oy W. Schauman Ab Mills	Finland	Pietarsaari ACFBG Unit	FW ACFBG	Active-Real	Operating	1983	1	204,819	15.3	35	28	Biomass/ Waste	Biofuels	Gaseous fuels	Syngas
Akzo Nobel/Berol-Kemi	Sweden	Stenungsund Oxochemicals Plant	Texaco	Active-Real	Operating	1980	1	200,000	14.9	33	27	Petroleum	Heavy fuel oil	Chemicals	Oxochemicals
Ube Ammonia Industry Co. Ltd.	Japan	CO Plant	Texaco	Active-Real	Operating	1982	1	200,000	14.9	36	27	Petcoke	Petcoke	Chemicals	CO
GE Plastics España	Spain	Cartagena Syngas Plant	Texaco	Active-Real	Operating	1997	1	160,800	12	26	22	Gas	Natural gas	Chemicals	CO
ASSI	Sweden	Karlsborg ACFBG Unit	FW ACFBG	Active-Real	Operating	1984	1	158,003	11.8	27	22	Biomass/ Waste	Bark	Gaseous fuels	Syngas
Norrsundet Bruks Ab	Finland	Norrsundet ACFBG Unit	FW ACFBG	Active-Real	Operating	1984	1	146,299	10.9	25	20	Biomass/ Waste	Bark	Gaseous fuels	Syngas
Fabrika Azotnih Jendinjenja	Former Yugoslavi	Gorazde Ammonia Plant	LP Winkler	Active-Real	Operating	1952	1	120,000	9	21	16	Coal	Lignite	Chemicals	Ammonia
Portucel	Portugal	Rodao ACFBG Unit	FW ACFBG	Active-Real	Operating	1985	1	87,800	6.6	15	12	Biomass/ Waste	Bark	Gaseous fuels	Syngas
New Central Jute Mills	India	Varanasi Ammonia Plant	Unspecified	Active-Real	Operating	1957	1	84,333	6.3	14	12	Unknown	Unknown	Chemicals	Ammonia
Frontier Oil & Refining Co. (Texaco Inc.)	United States	El Dorado IGCC Plant	Texaco	Active-Real	Operating	1996	1	80,559	6	64	11	Petcoke	Petcoke, Ref. waste &	Power	Electricity & HP steam
Sydkraft AB	Sweden	Värnamo IGCC Demonstration Plant	FW PCFBG	Active-Real	Operating	1993	1	80,000	6	18	11	Biomass/ Waste	Biofuels	Power	Electricity & District heat
Gazprom	Russia	Unspecified	Methanol Plant Unspec	Active-Real	Operating	1995	1	67,500	5	11	9	Unknown	Unknown	Chemicals	Methanol
Fushun Detergent Co.	China	Fushun Oxochemicals Plant	Shell	Active-Real	Operating	1991	1	60,000	4.5	10	8	Petroleum	Vac. residue	Chemicals	Oxochemicals
Hidro Nitro Española SA	Spain	Monzon Ammonia Plant	Unspecified	Active-Real	Operating	1957	1	41,700	3.1	7	6	Unknown	Unknown	Chemicals	Ammonia

4.4. Fertilizers

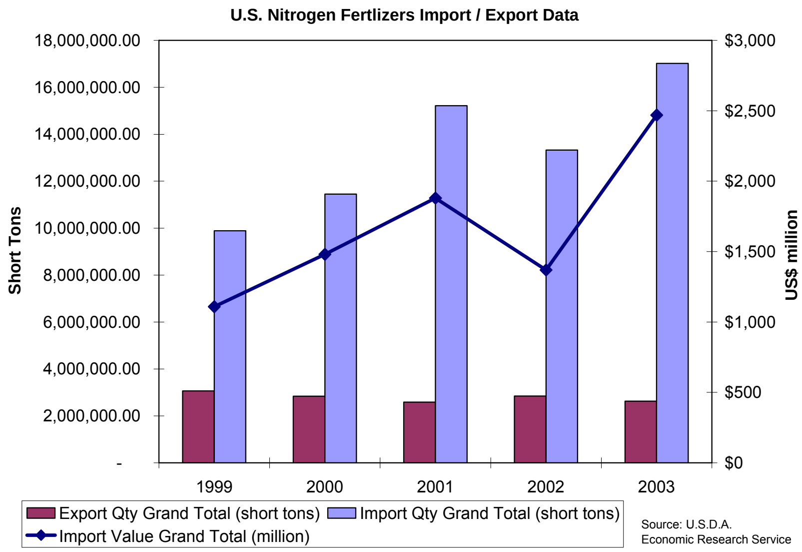
Deriving ammonia from coal gasification is one way to reduce the shortage of nitrogen fertilizers, and to decouple the cost of nitrogen fertilizers from natural gas prices. With its coal reserves and proximity to fertilizer markets, North Dakota is particularly well positioned to play a larger role in the fertilizer industry.

More than 80% of the world's production of ammonia and ammonium compound derivatives is used as fertilizer. Of the remaining 20%, 5% is used in chemical manufacturing and the remainder is used for refrigerants and in the pulp and paper industry. Great Plains Synfuels Plant is the 10th largest producer of ammonia and ammonium compounds in the US (approximately 2% of the US market, and 15% production capacity of the larger plants)[52]. Dakota Gasification currently markets anhydrous ammonia and ammonium sulfate fertilizers.

Nitrogen consumption has been increasing in the U.S. and worldwide, and the International Fertilizer Industry Association predicts a further increase in demand. U.S. imports of nitrogen fertilizer have also been increasing due to declining domestic production. Since 1998, 19 ammonia plants in the US have either shut down or gone idle due to unprofitable operations caused by rising natural gas[53] prices. This has resulted in a 30% reduction of US ammonia production capacity[54]. While the price of nitrogen fertilizers in the U.S. has not increased above the global market price, the combination of increasing worldwide demand (for example in Brazil), higher natural gas prices, and decreasing US production has pushed the price of ammonia-based fertilizers upward[55] [56].

While local fertilizer production might be an attractive opportunity given the trend of increasing prices and North Dakota's proximity to US fertilizer markets, a number of barriers prevent the project team from recommending it. Dakota Gasification must choose between the production of substitute natural gas and the production of ammonia. Natural gas prices and ammonia fertilizer prices are inextricably linked, so it is unlikely that one will increase without the other. Therefore, it is unlikely that the incentive to produce one more than the other will change. Dakota Gasification's current strategy of producing fertilizer, a commodity with nearly infinite shelf-life, in the shoulder seasons when natural gas prices drop is the best possible strategy. In short, it is unlikely that fertilizer production will increase with current infrastructure. Due to this fact, any additional fertilizer production would depend on the construction of a greenfields plant. While this may be a desirable development in the long term, it would not make use of energy or materials that are currently underutilized.

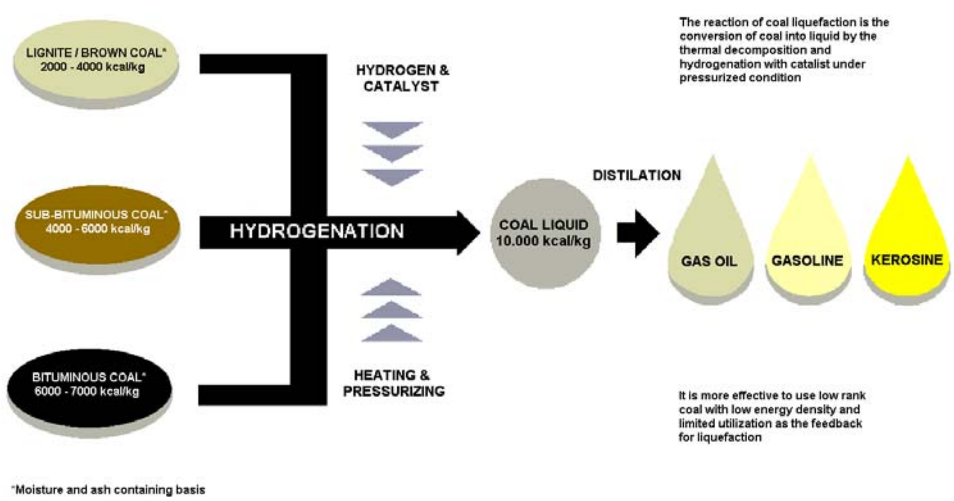
Figure 39: Import/Export Trends in Nitrogen Fertilizers



4.5. Coal to Fuels

The primary and original aim of the Coal Country Development Initiative project was to explore economic opportunities that leverage the resources of Coal Country's energy plants. However, development potential also clearly exists in the increased utilization of the region's lignite. One of the most intriguing concepts for a new lignite-based industry is coal-to-liquid fuels or coal liquefaction. Recent spikes in energy prices and media attention on national energy security and alternative fuel supplies prompts us to address the prospect of coal liquefaction in Coal Country.

Figure 41: Direct Coal Liquefaction Process[57]



Coal liquefaction uses pulverized coal as a feedstock to produce liquid fuels such as diesel, gasoline, or aviation gas. The liquefaction process can be either direct or indirect. Direct coal liquefaction involves mixing pulverized coal with a liquid solvent and then treating this coal slurry with hydrogen and various catalysts under high heat and pressure. Alternatively, indirect coal liquefaction first gasifies the coal into small molecules of carbon monoxide and molecular hydrogen. Special catalysts are then used rebuild the molecules into liquid hydrocarbons and remove byproducts. The Fisher-Tropsch indirect process, made famous by South Africa's Sasol, is the oldest and most tested liquefaction technology. Sasol has used their gasification facilities in South Africa to produce liquid fuels since the 1950s. Trade embargos resulting from apartheid necessitated that the country produce transportation fuels domestically.

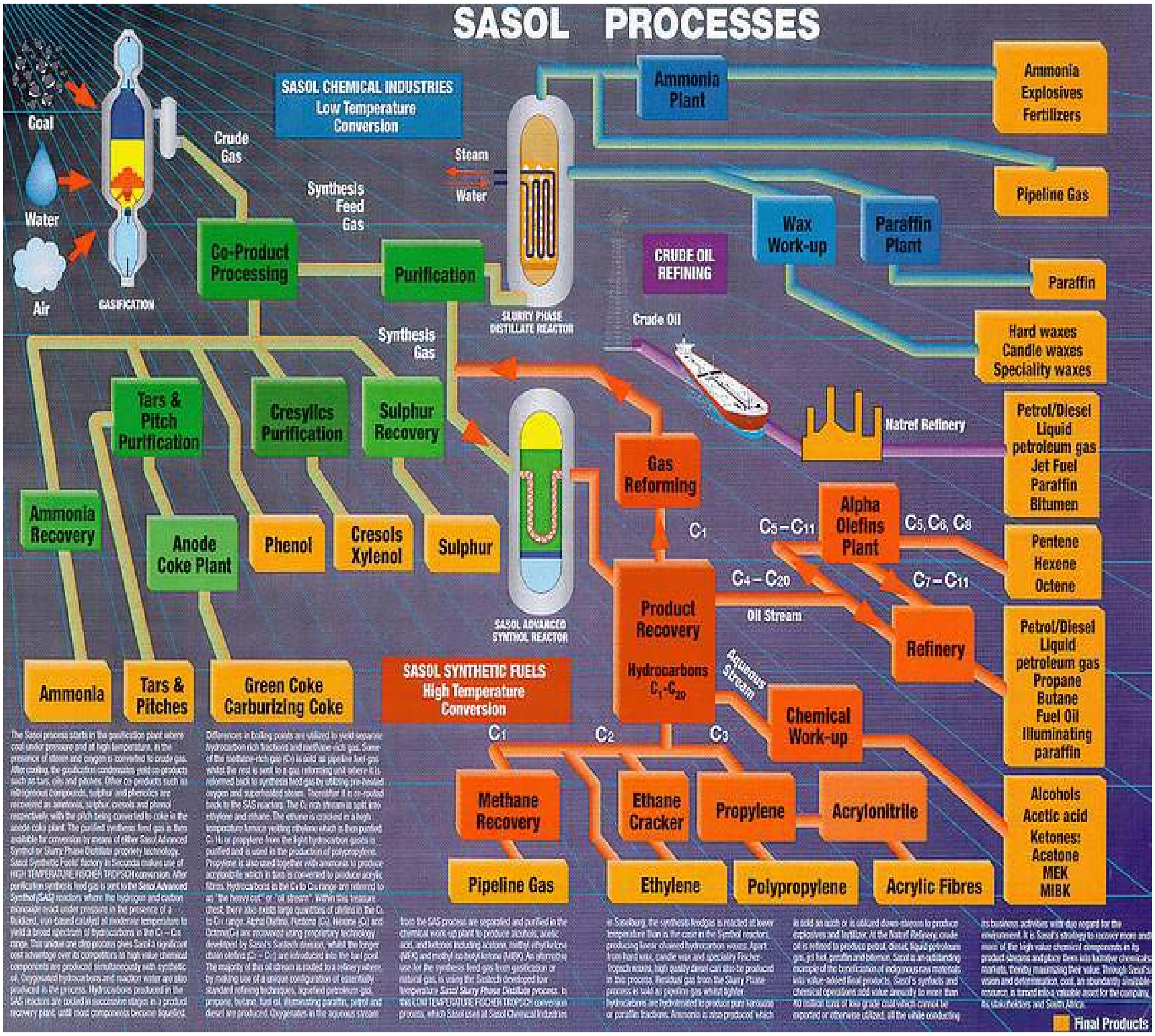
Today South Africa produces 150,000 barrels per day of oil from coal, but the Chinese will soon become the worldwide volume leader in coal-to-liquid fuels. Sasol is involved with the Chinese government and related businesses in two plants currently planned for Inner Mongolia. These two plants are part of a larger $6 billion initiative that should deliver an annual capacity of 60 million tons of oil. The first one (1) million ton per year plant is expected to produce gasoline and diesel by 2007.[58] Interestingly, Headwaters Incorporated, Great River Energy's ethanol partner, is also involved in the Chinese coal-to-liquid fuels initiative. According to a Headwaters' press release, the company owns a direct coal-to-liquid technology that has been licensed by the Shenhua Group Corporation of China for a 50,000 barrel per day plant planned in Inner Mongolia (see Appendix).[59]

Recent trends have revived interest in coal liquefaction technologies. Primarily, oil prices have reached new heights ($70/barrel in August 2005) thanks to uncertain swing capacity from global reserves, increasing demand from China and India, US refining capacity limitations, and increasing reserve replacement costs. These high prices as well as a growing desire for energy independence from foreign sources create the political will to explore more domestic energy resources. While many may hope for a future based on hydrogen automobiles, liquefaction of coal is the easiest way to produce transportation fuels compatible with the fuel delivery current infrastructure. In addition, lignite is considered an ideal feedstock for coal liquefaction because of its low relative cost and high hydrogen content. Mine mouth refineries near the Freedom or Falkirk Mines would appear to be the most attractive in terms of scale, operating costs and logistics.

North Dakota has received recent attention regarding coal liquefaction with the announcement of a memorandum of understanding between Headwaters, Incorporated, Great River Energy, North American Coal, and Falkirk Mining Company to develop a coal liquefaction facility near Coal Creek Station. This team proposes a 10,000 barrel per day (bpd) facility with expansion opportunities to 50,000 barrels per day. The construction costs for such a facility are considerable, ranging from $750 million for the initial 10,000 bpd plant to approximately $3 billion for a 50,000 bpd facility.

If diesel is included in the fuel mix at the proposed coal liquefaction plant, coal-based diesel could be blended with biodiesel to be produced at the facility planned near Minot. Announced in March of 2005, the Minot facility would use industrial-grade canola to produce biodiesel. Most biodiesel available commercially is blended with petroleum diesel at ratios of 2-20% biodiesel. A coal/canola derived diesel blend could be marketed as clean 100% North Dakota "home-grown" fuel.

Figure 41: Sasol's Coal Gasification-based Industries



5. Concept Summaries

The following are concept summaries for the industries that appear most compatible with Coal Country. The summaries are organized by the following categories: target businesses and partners, anticipated local resources required, prospective sites, challenges, impacts to the local economy, environment and community, national examples, and future considerations.

5.1. Commercial Greenhouses

Summary

By definition, greenhouses require relatively stable climatic parameters of temperature and humidity, and often have significant heating demands outside the summer months. The hot water and steam available at Coal Country's power stations and gasification plant could provide a low-cost input for these greenhouses. Highly scaleable in size, greenhouses could be developed as small operations (≤1 acre) or as 5-10 acre and larger complexes. Other resources available at the power stations, like low-cost land and potable water, will be valuable for prospective greenhouse growers.

Targeted Business

Primary businesses

Commercial greenhouses

- Vegetables
- Herbs
- Cut flowers
- Bedding, potted, and ornamental plants
- Tree seedlings

Co-production / Auxiliary businesses

Power stations and/or gasification plant
Possible connections to existing agriculture

Local Resources

- Steam or hot water for space heating
- Low-cost land and potable water
- Access to interstate highways, markets east, west, and south of Mercer County

Prospective Sites

- Coyote Station and Antelope Valley Station
- Leland Olds Station (no data available) and Stanton Station (steam only)
- Great Plains Synfuels Plant

Challenges

The primary obstacles to the development of greenhouse agriculture operations in Coal Country are distance to customers and the capital costs for heating infrastructure and equipment. Larger greenhouse operations will present the opportunity to dilute the costs of capital heating infrastructure, the objective being to provide a sufficiently low-cost heat resource to outweigh the marginal costs of truck transportation to distant markets (compared with alternative locations). Coal Country greenhouse producers would be well positioned to serve Bismarck and other in-state markets as well as metropolitan markets in Minneapolis and Chicago. Points west and south (Denver and Seattle) could also be served, though these cities have more proximate competing greenhouse producers.

Another barrier is the high initial cost of piping and heat exchangers to deliver heat from the energy plants to the greenhouses. However, from a recent proposal from OtterTail Power (Coyote Station) to a prospective greenhouse producer, the utility believes it can finance this much of this infrastructure and still provide a low-cost heating resource to the greenhouses. In addition, the Mercer County Energy Park adjacent to Antelope Valley Station already has piping installed.

Economic, Environmental & Community Impacts

Many greenhouse agriculture operations would be seasonal, operating 6-8 months per year. However, some high value products like herbs and some bedding plants, and tree seedlings might be cost effective for year-round operation. Greenhouse operations provide various employment opportunities including direct plant care, equipment maintenance, managerial and administrative, logistics, and sales and marketing. Depending on the scale of the greenhouse operation as many as 2-5 jobs could be created per greenhouse acre.

The environmental impacts of greenhouse agriculture are limited, with water consumption and the restricted application of pesticides and herbicides among the most significant.

The operations and administrative jobs at the greenhouses would highly accessible to varying skill levels of labor force. Greenhouses might be an attractive employment option for the spouses of energy plant employees. The local community would also benefit from the increased off-season or shoulder season availability of agricultural products. The opportunity for expanding community-based agriculture also exists.

National / International Examples

- Neideraußen, Germany (see Hortitherm Greenhouse Park in Benchmarking section)
- Home City, Pennsylvania (Pennsylvania Electric Company's Homer City Station)
- Washingtonville, Pennsylvania (Pennsylvania Power & Light Montour Station)
- Estevan, Sasakchewan, (SaskPower's Shand Greenhouse)

Roadmap

The commercial greenhouse development roadmap is largely a conventional economic development recruitment process. However, in addition to attracting major national growers, local development officials should also target local and regional growers that have the technical and business expertise or potential to expand.

5.2. Biofuels

Summary

Ethanol production would be at the core of a biofuels refinery, but other high-value, bio-based products could be added as technical and economic feasibility permits. A biodiesel component, based on canola, could also be added.

Targeted Business

Primary businesses

Ethanol refinery – grain feedstock

Ethanol refinery – cellulosic

Possible integrated biorefinery

Biodiesel component

Co-production / Auxiliary businesses

Power stations and/or gasification plant

Existing and potential crop production in Mercer County and vicinity (wheat, straw, switchgrass, etc.)

Local Resources

- Steam from power stations or gasification plant
- Low-cost power
- Access to rail, water, interstate highways
- Access to markets: would be among westernmost of US ethanol refineries

Prospective Sites

- Coyote Station or Great Plains Synfuels Plant in Beulah
- Coal Creek Station in Washburn

Challenges

The primary challenges include the distant sources of conventional corn feedstock (southeastern North Dakota and northeastern / north-central South Dakota) and the high cost of rail transport to/from Mercer Country.

Economic, Environmental & Community Impacts

A 40 million gallon per year ethanol plant[60]

- 35-40 direct jobs ($40,000 average wages)
- 3.4x employment multiplier
- Economic multiplier effect totaling $90 MM/year to region.

A 15 million gallon per year soy diesel refinery[61]

- Approximately 60 direct jobs (with crushing)
- 3-6x employment multiplier
- Economic multiplier effect totaling $90-100 MM/year to region.

Positive environmental impacts would include an increase in renewable fuels capacity and the possibility of a vastly improved energy balance with power plant co-location and cellulose feedstocks. Negative impacts mostly revolve around the nuisance odors commonly associated with ethanol and biodiesel refining, though newer plants have built in thermal oxidizers that capture these emissions.

Community impacts include high-wage jobs with above average economic multipliers and pride in contribution to energy security and renewable energy production. Biofuels and other bio-based products will increase the value of local agriculture with direct benefits to farmers and multiplier effects to local economy.

National Examples

85 ethanol plants are operating in the US (as of May 2005), most of which use corn feedstock. The Northern Lights Ethanol refinery near Big Stone, South Dakota is a prime example of co-location and shared services between an ethanol refinery and a power station. A 50 million gallon per year biodiesel refinery, which will be the largest in the US, is currently planned for Minot, North Dakota.

Roadmap

The biofuels roadmap would involve a two-pronged effort to test the feasibility of an additional grain-based ethanol refinery (corn or wheat) while also pursuing the opportunity to host one of the nation's first cellulose-based integrated biorefineries.

5.3. Fertilizers

Summary

The fertilizer industry could manufacturer ammonia and ammonia derived fertilizers, namely urea and urea ammonium nitrate (UAN), by means of coal gasification. Over the past 5 years, a number of natural gas-based U.S. ammonia plants have shut down or idled as a result of high and volatile natural gas prices. Using coal instead of natural gas as a feedstock will provide stability to fertilizer prices. As part of the Federal Government's Vision 21 program, the feasibility of a coal gasification ammonia manufacturing plant can be improved by co-production of syngas for power generation, liquid fuels, and ammonia.

Targeted Business

Primary businesses	*Co-production / Auxiliary businesses*
Ammonia production	Electricity generation
Urea production	Chemical byproduct production
Ammonium sulfate production	Low-grade heat production

Local Resources

- Lignite coal,
- Cheap heat energy and electricity from lignite and local lignite power plants,
- Cheap, stably priced lignite for production of synthesis gas,
- Access to rail, water, natural gas, interstate highways
- Access to markets: agricultural regions of the state and region

Prospective Sites

- Beulah: current lignite mines at Freedom Mine and Beulah Mine.
- Leland Olds Station – Managers of Leland Olds Station are considering repowering its Unit 1 with an IGCC unit. Integrating a larger gasifier and an ammonia plant into the repowering project may add value to the resources in use and allow easier financing of the project due to increases in expected revenues.

Challenges

Capital fundraising: Construction of a 1,000 short ton per day coal gasification ammonia plant would cost approximately $270 million. An equivalent natural gas ammonia plant costs less than $190 million (varies from plant to plant)[62].

Since 1998, 19 ammonia plants in the US have either shut down or gone idle due to high natural gas feedstock price. At $2.00~$2.50, the cost of natural gas constitutes about 70%~75% of the total cost of ammonia, while at $5.00~$7.00, natural gas is 85%~95% of ammonia production costs[63]. Using coal as an input and locating in the center of a region with high demand could allow ammonia from the plant to compete with imports based on natural gas.

According to an engineering consultant[64], the approximate costs of manufacturing 1,000 short tons per day of ammonia in the U.S. are:

- Feedstock requirements = 34,000 Btu(HHV)/short ton(NH_3)
- Operations, maintenance, other requirements = $30/short ton
    - At natural gas price of $6.00/MMBtu, $234/short ton
    - At natural gas price of $2.50/MMBtu, $115/short ton
- Estimated cost of producing ammonia from petcoke from the Coffeyville plant is $149/short ton
- Natural gas price indifference will be at $3.50/MMBtu
- Transportation from the Gulf Coast region to the Corn Belt is roughly $45/short ton
- The feedstock price indifference must be adjusted for cost of coal and transportation

Economic, Environmental & Community Impacts

The economic impacts of such a plant are hard to quantify. The annual revenues from fertilizer sales would exceed $71.2 million at $192 per short ton of delivered ammonia delivered (the average price of imported ammonia in 2003 plus the cost of delivery), but additional revenues would be gained from sale of electricity, natural gas, and other gasifier byproducts. A plant in Coal Country would likely enjoy a price advantage over imported fertilizers based on natural gas because of reduced transportation costs to areas of highest demand. Employment and other data from examples like the Coffeyville refinery are not freely available.

Increased depletion of lignite resources, and increased habitat, air, and water impacts associated with mining. Ammonia-derived fertilizers contribute to acid rain during product application and use stages. Using the gasification technology for the co-generation of electricity and ammonia could reduce pollutant emissions per kilowatt-hour generated.

Technical and administrative jobs at wages similar to those paid at gasification and power plants. Another favorable impact is the stable ammonia fertilizer prices based on coal rather than natural gas for the local farmers.

National Examples

Coffeyville Plant in Kansas listed in the benchmark section.

Rentech (Denver) is planning to purchase and convert an ammonia plant from natural gas to coal feedstock by adding a coal gasification unit. The plant under consideration is an 830 metric ton per day located in East Dubuque in Illinois, owned by Royster-Clark (Norfolk, VA). The plant's output will be supplemented by the production of other Fischer-Tropsch liquids and electricity. The purchase will cost $63 million for the plant and $13 million in net current assets, working capital, and inventories[65].

Roadmap

As mentioned above, fertilizer production in Coal Country is unlikely to increase unless a new IGCC facility, gasification plant, or liquefaction plant is constructed. Instead of pursuing one of these projects to promote a fertilizer industry, MCED and the Department of Commerce should insure that the necessary pieces are in place to support a fertilizer industry should another plant come online.

5.4. Coal Liquefaction

Summary

A coal liquefaction plant would convert lignite into gasoline, diesel, and/or aviation gas.

Targeted Business

Primary businesses

Synfuels refinery
- Diesel
- Gasoline
- Aviation gas

Co-production / Auxiliary businesses

Electricity generation
Chemical byproduct generation
Low-grade heat production
Increased coal extraction

Local Resources

- Lignite coal
- Gasification expertise
- Water
- Access to rail, water, natural gas, interstate highways
- Labor pool

Prospective Sites

- Beulah: Freedom Mine
- Washburn: Falkirk Mine

Challenges

Pursuit of a coal liquefaction facility as an economic development strategy has associated risks. First, a project of this scale will take several years and ultimately billions of dollars to become operational. Market shifts and changes in political climates, environmental regulations, and technologies all represent hurdles to the project. The Department of Commerce should facilitate project partners to address these hurdles. Some cost estimates indicate that the capital cost of a 5,000 barrel per day coal liquefaction plant would exceed $600 million[66]. More recent estimates reflect a capital costs for a 10,000 barrels per day plant to be in the approximate range of $750 million. These numbers need to be reconciled and factored into a final decision. The US Department of Defense estimates that a plant could produce diesel at a competitive price with $35/barrel crude oil[67]. An analysis would have to be made of the competitiveness of coal liquefaction with projected refined oil prices.

Second, the impact of a project of this magnitude on other potential opportunities needs to be considered.

Third, it is possible that many of the liquefaction byproducts will not be utilized or will be shipped out of state for added value processing. The Department of Commerce should insure that byproducts are processed in state to the extent feasible. Instead of simply helping the partner companies find consumers for byproducts, the Department of Commerce should facilitate maximizing the processing in state to the extent feasible. The Department of Commerce may want to consider attracting industries that can use byproducts locally.

Economic, Environmental & Community Impacts

Economic: The economic impacts on the host community of a successful coal liquefaction facility would be significant. The construction and operation of the facility would demand hundreds of employees and contractors. The operation of a 5,000-10,000 barrel per day plant would require 500 employees. The demand for 12 million additional tons of coal per year would also have significant impacts. This would more than double the annual output from Freedom Mine, one of the nation's largest. Positive and negative impacts should be weighted.

National Examples

Numerous states are currently planning or considering coal liquefaction facilities, but only one facility is actually under construction. No coal liquefaction facilities are operational in the US. WMPI Ltd leads a variety of partners in constructing the liquefaction facility in Pennsylvania. South Africa's Sasol facility remains the largest operational example in the world. China is rapidly aiming to become the leader in this field.

Future Considerations

The gasification processes used for indirect liquefaction of coal and IGCC electricity production are also compatible with the generation of hydrogen. In fact, research conducted at the Energy and Environmental Research Center at the University of North Dakota indicates that lignite may actually be preferable to other varieties of coal for this process[68]. Hydrogen is expected to be the transportation fuel of choice in 20-30 years. Any IGCC or liquefaction facilities should investigate their options for transitioning to hydrogen production in the future.

6. Marketing and Roadmaps

6.1. General Positioning and Promotion

This report describes a variety of industries that could use the byproducts available in Coal Country. While strategies for approaching specific companies should be customized as much as possible, it will be important to present a unified marketing image and brand for the initiative and the region.

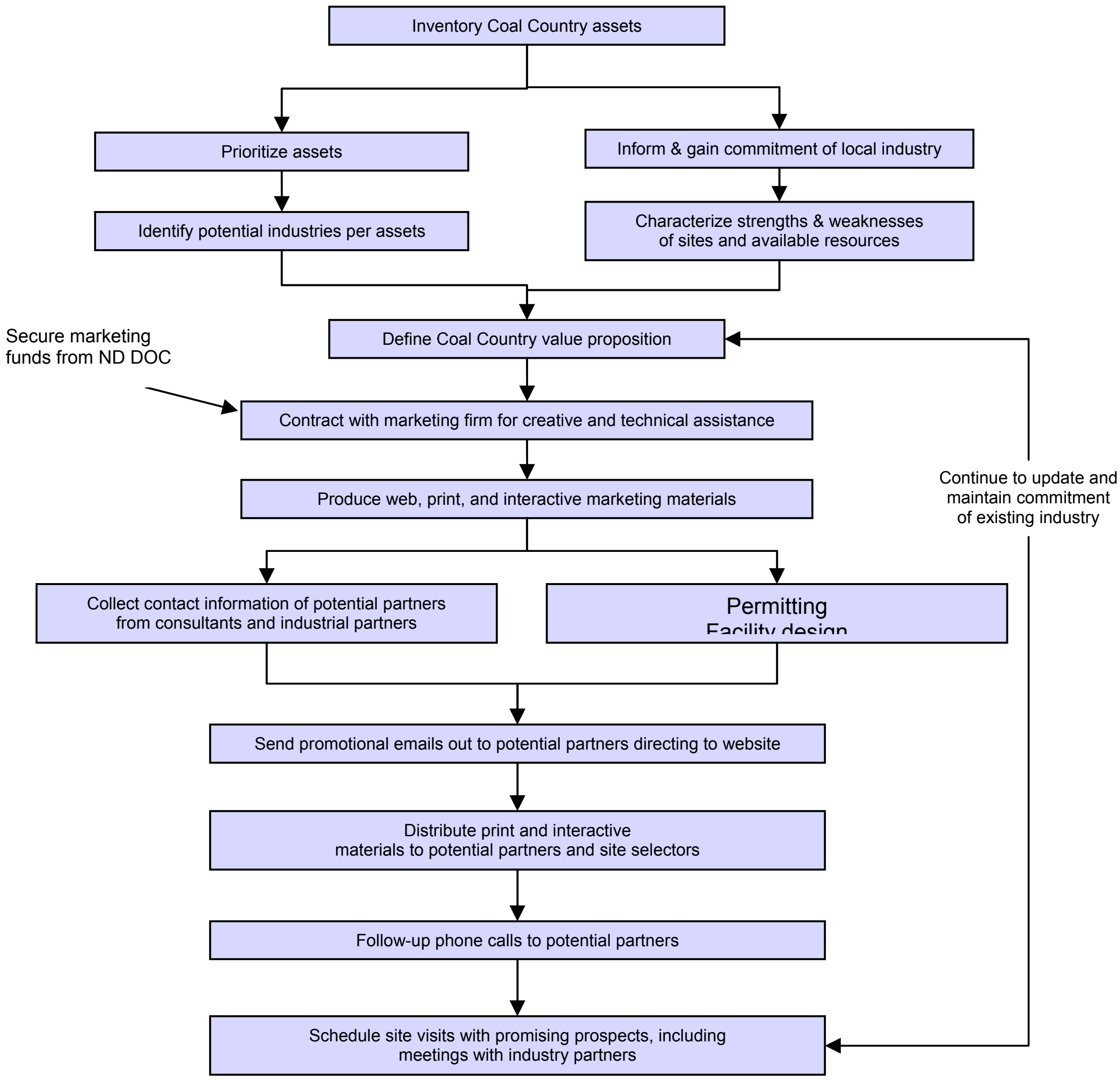
The overarching image of Coal Country presented to all potential partners should highlight its key strengths: low costs (of energy, taxes, insurance, land, and living), well trained and dependable workforce, business friendly regulatory environment, and excellent quality of life.

Additionally, this marketing effort will be most effective if it addresses certain issues about which outsiders will be skeptical. Outsiders will think of North Dakota as remote, cold, and exclusively agricultural. To overcome these prejudices it will be important that the materials appear sophisticated and tech savvy, that access to markets is addressed, that successful and recognizable names doing business in North Dakota are highlighted, and that the state is portrayed as a wonderful place to settle and make a life.

> *Next Steps: In order to transform these concepts into concrete actions, it will be important to retain a skilled graphic design firm and maintain strict editorial control over*

their work. MCED should work with ND DOC to secure up to $10,000 in funds for the production of web, print, and other promotional media. It will also be useful to seek counsel from current industrial and consulting partners from both in and out of state. They will be able to provide advice regarding the professionalism of the design and promotional strategies and medial that will be most influential with potential partners. A roadmap for general marketing of the Coal Country Initiative follows.

Figure 42: Development Roadmap: General Marketing



6.2. Specific Industry Roadmaps

Roadmaps for the most promising of the Coal Country development concepts are presented in the following sections. Immediate next steps are highlighted and flow charts are provided as a guide to staging of business and economic development activities. Target partners are presented where available.

6.2.1. Commercial Greenhouses

The roadmap for the development of a commercial greenhouse industry in Coal Country involves a two-pronged approach of recruitment and business development. The conventional recruitment approach targets existing players including major growers of vegetables and herbs, cut flowers, bedding, potted, plants and ornamental plants, and tree seedlings (all of which are headquartered out-of-state). Contact information for the leading firms in the US and Canada are provided in Figures 45 and 46. However, more immediate opportunities may be available by providing technical and business development assistance to existing in-state greenhouse growers with the objective of expanding operations to Coal Country energy plant sites.

Next Steps: MCED and ND DOC have already begun courting individual out-of-state greenhouse growers and now must plan for a more comprehensive marketing and outreach program to major national and Canadian producers. This will include the preparation of industry-specific promotional materials and direct marketing with these firms. ND DOC can also assist MCED in a parallel strategy of identifying promising local growers and providing targeted business development assistance with the goal of establishing new greenhouse facilities adjacent to one or more of Coal Country's energy stations. With both strategies, MCED should take the lead role in identifying the most interested energy partners and advancing the offerings to include cost ranges for energy services and specific development sites.

Figure 43: Development Roadmap: Commercial Greenhouses

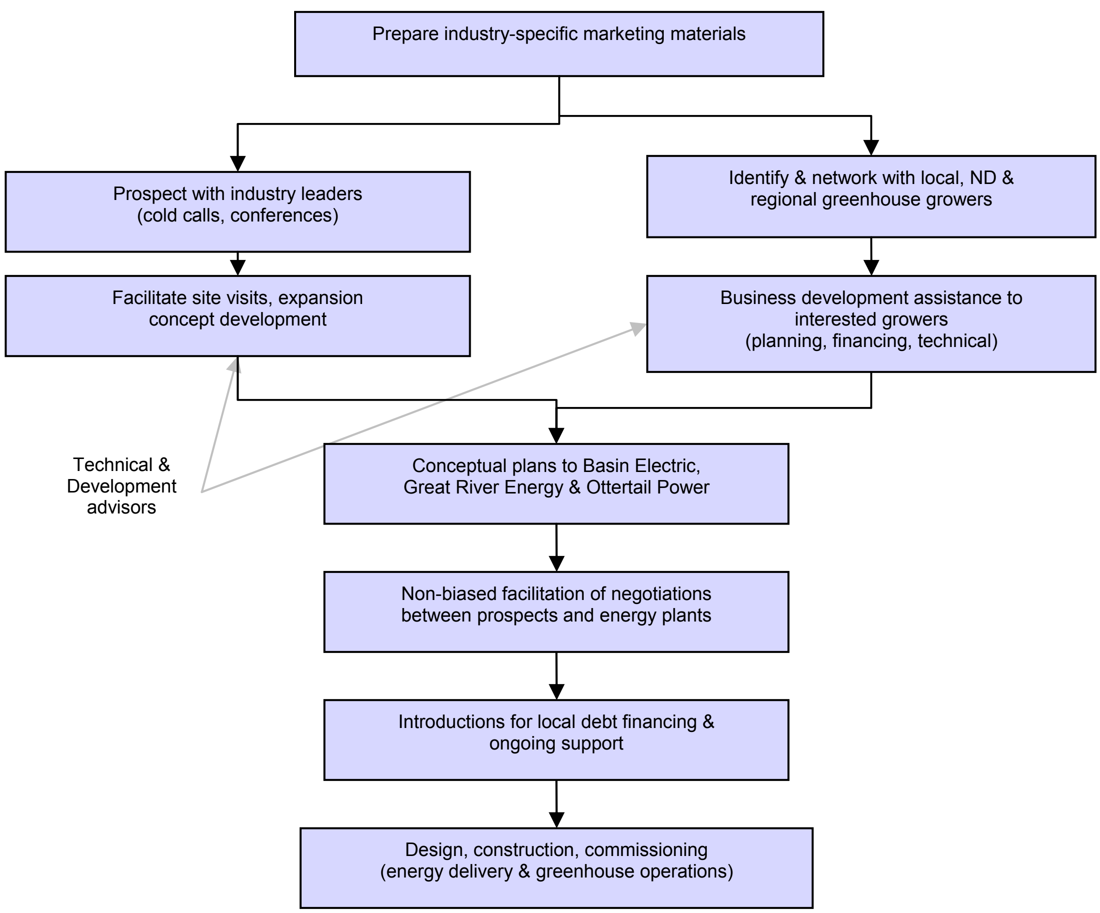


Figure 44: Top 20 US-based Greenhouse Growers (non-food products)[69]

Company	State	Web	Contact	Phone	Locations
Hines Horticulture	CA	www.hineshorticulture.com	Robert A. Ferguson	949-559-4444	AZ, CA, FL, GA, NY, OR, PA, SC, TX
Yoder Brothers	OH	www.yoder.com	William G. Rasbach	330-745-2143	FL, SC, PA, ON, and Columbia
Color Spot Nurseries, Inc.	CA	www.colorspot.com	Michael Vukelich	760-695-1430	
Kurt Weiss Greenhouses	NY	www.kurtweiss.com	Wayne Weiss	631-878-2500	NY, FL, SC, and CT
Speedling, Inc.	FL	www.speedling.com	Richard Lim	813-645-3221	FL, GA, TX, CA, China, other intl
Costa Nursery Farms	FL	www.costanursery.com	Maria Costa Smith	305-247-3248	
Paul Ecke Ranch	CA	www.ecke.com	Paul Ecke, III	760-753-1134	
Altman Plants	CA	www.altmanplants.com	Ken Altman	760-744-8191	CA, TX, AZ, and FL
Metrolina Greenhouses	NC	www.metrolinagreenhouses.com	Richard Van Wingerden	704-875-1371	
The Sun Valley Group	CA	www.thesunvalleygroup.com	Lane Devries	800-747-0396	CA
Delray Plants, Inc.	FL		Ann Thompson	561-498-3200	
Nurserymen's Exchange	CA	www.bloomrite.com	Robert Bruno	650-726-6361	CA, FL, and Hong Kong
Oglevee Ltd.	PA	www.oglevee.com	Jim Heck	724-628-8360	PA, GA, NY, CO, ON, and BC
Milgro Nursery, Inc.	CA			805-383-3616	
Woodburn Nursery & Azaleas	OR	www.woodburnnursery.com	Tom Fessler	888-634-2232	
Powell Plant Farm	TX	www.powellplant.com	Tom Dickerson	800-488-9536	
Matsui Nursery	CA	www.matsuinursery.com	Andy Matsui	800-793-6433	orchids
Floral Plant Growers LLC	WI	www.natbeauty.com	Dean Chaloupka	920-863-2107	Focused on Midwest markets
Hermann Engelmann Greenhouses	FL	www.exoticangel.com	Hermann Engelmann	800-722-6435	
Green Circle Growers	OH	www.greencirclehome.com	John Van Wingerden	440-775-1411	

Figure 45: Top 10 American and Top 20 Canadian Greenhouse Growers (food products)

Company	Location	Acres	Web	Contact	Phone
United States					
EuroFresh	Wilcox and Snowflake, AZ	240	www.eurofresh.com	Dwight Ferguson	520-384-4621
Village Farms	Fort Davis, TX, Ringold PA	130	www.villagefarms.com	Mike Degiglio	732-676-3325
Houwelings	Oxnard, CA	140	www.houwelings.com	Casey Houweling	604-946-0844
Sunblest Farms	Fort Collins, CO	86		Ludo Van Boxem	719-749-2510
Sunco LLC	Las Vegas, NV	40	www.lasvegas-delight.com	Ken Gerhart	702-649-4930
Dominion Virginia Power	Virginia	35	www.dom.com		
Intergrow Greenhouse Inc.	Rochester, NY	34			585-567-2678
Nebraska Cooperative Council	Lincoln, NE	30	www.nebr.coop	Robert Anderson	402-475-6555
Hollandia Greenhouses Ltd.	Ventura, CA, Fort Pierce, FL	30	www.hollandia.ca		
ADM	Decatur, IL	18	www.admworld.com		800-637-5843
Decatur Farms	Decatur, IL	10			
Canada					
Mastron Enterprises	Leamington, ON	53		Jack and Laney Pomp	519-322-2069
Great Northern Hydroponics	Leamington, ON	53			519-326-6179
DiCiocco Farms	Leamington, ON	49		Henry DiCiocco	519-326-2339
Houweling Nurseries	Delta, BC	48	www.houwelings.com	Casey Houweling	604-946-0844
Amco Farms	Leamington, ON	40	www.amcoproduce.com	Pat Amicone	519-326-9095
Sabelli Farms	Leamington, ON	38		Tony Sabelli	519-326-9201
Veg Gro Inc.	Leamington, ON	36	www.veggro.com	Rick Wilkinson	800-419-4256
Nature Fresh	Leamington, ON	35	www.naturefresh.ca	Peter Quiring	519-326-8603
CanAgro	Delta, BC	31			
Suntastic Hothouse	Exeter, ON	30	www.suntastic.ca	Burkhard Metzger	519-235-3357
Mucci Bros	Leamington, ON	30	www.muccipac.ca	Danny Mucci	519-326-8881
Les Serres du St. Laurent	Portneuf, Quebec	30	www.savoura.com/en/	Jacques Gosselin	418-286-6681
Cervini's	Leamington, ON	25	www.lakesideproduce.com	Chris Cervini	519-322-1959
Delta Pacific	Delta, BC	25			
St. Davids Hydroponics	St. Davids, ON	24			
Gipaanda	Delta, BC	24		David Ryall	604-946-1310
Double Diamond	Leamington, ON	24		Nick Mastronardi	519-326-1000
Howard Huy Farms	Leamington, ON	24		Howard Huy	519-324-0631
Hazelmere	Surrey, BC	21			
Hydro-Serre	Mirabel, Quebec	17	www.hydroserre.com	Martin Desrochers	450-475-7924

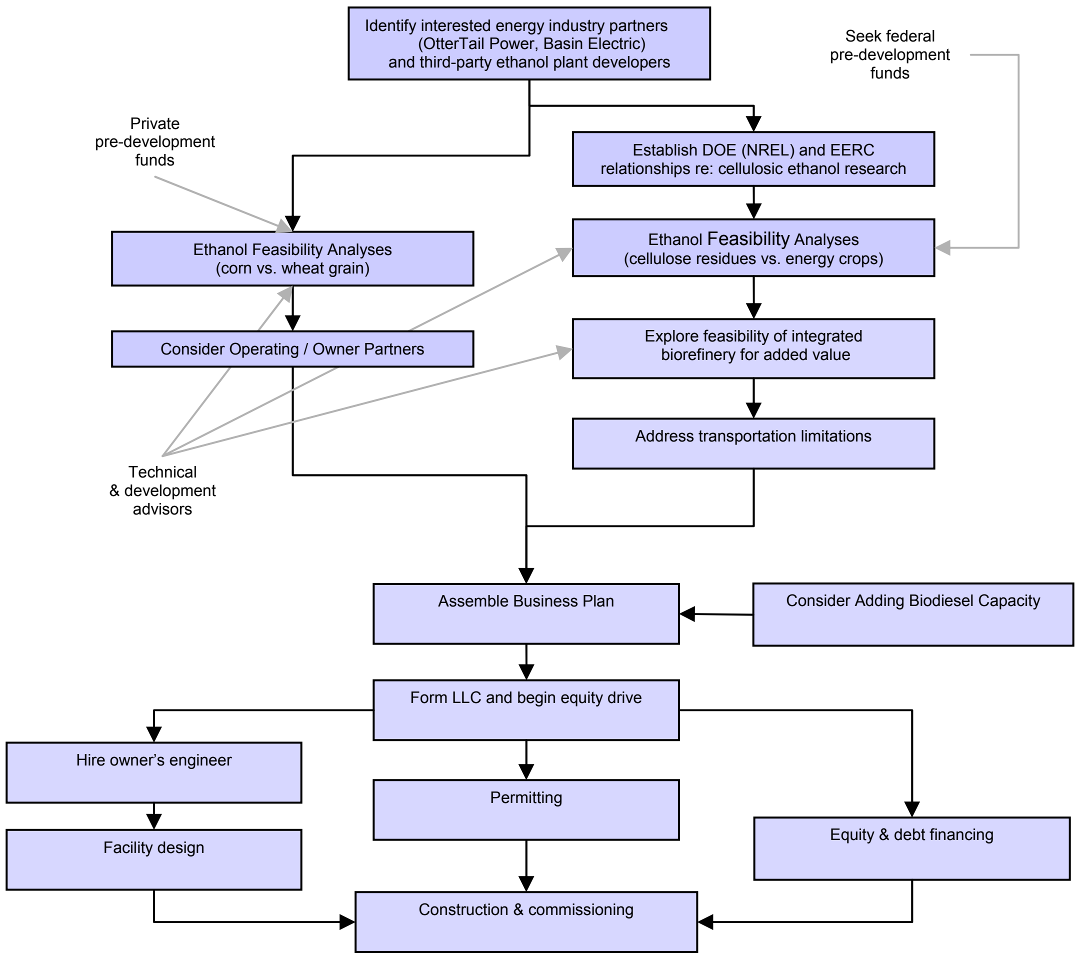
6.2.2. Biofuels

The roadmap to development of one or more biofuels (ethanol) refineries within Coal Country involves a two-pronged approach, assessing the feasibility of a second grain-based refinery (corn or wheat) in the region while also looking to the future of ethanol and exploring the opportunity of building a cellulose-based plant. Any public initiative in this regard must be mindful and protective of the investments currently committed by GRE & Headwaters Incorporated.

The roadmap would begin with confirming the interest of the region's energy industry players, specifically OtterTail Power and Basin Electric. The Department of Commerce and MCED could also facilitate the re-introduction of the region to third-party ethanol industry developers. Recent pressure to develop home-grown fuels and advancements in alternative feedstocks might provide renewed opportunity. The identification of industry champions would be followed by a comprehensive testing of feasibility. The feasibility assessments should follow parallel tracks with grain-based plants being evaluated along with cellulose refineries.

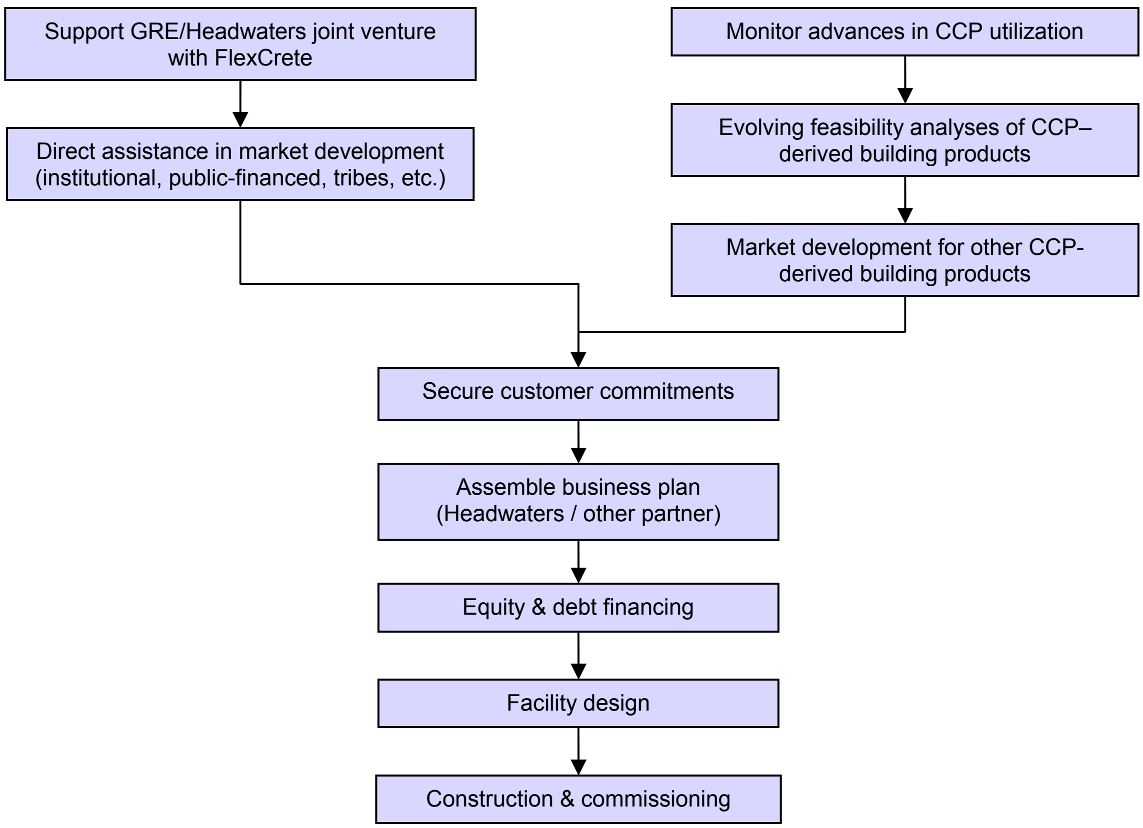
Next Steps: MCED and Commerce should continue discussions with OtterTail Power and Basin Electric to define their interest and level of involvement in a co-located ethanol refinery. Third-party ethanol developers should be recruited again (by Commerce and interested energy industry partners) to specifically consider the opportunities at Coyote Station and/or Great Plains Synfuels. Commerce should insert itself into the DOE-sponsored effort to move the ethanol industry to cellulosic feedstocks. Coal Country, with low-cost energy resources and abundant agriculture residues, is very well positioned to host one of the nation's first bioethanol plants.

Figure 46: Biofuels Refinery



6.2.3. Building Products

Figure 47: Building Products

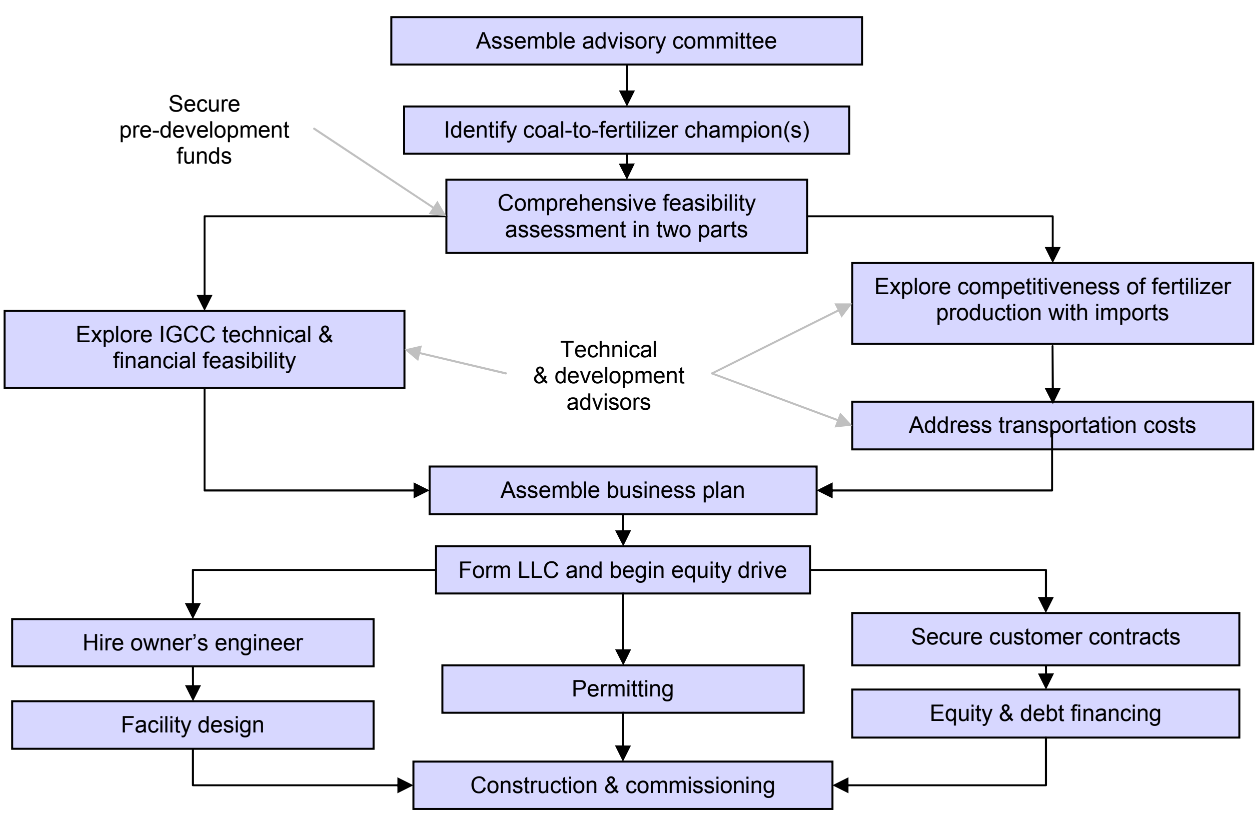


6.2.4. Fertilizers

The roadmap to pursue a larger fertilizer industry in Coal Country is completely dependent on private sector players. To produce more fertilizer, existing coal boilers will have to be re-powered as IGCC facilities or new IGCC plants will have to be built. For either of these to occur, utilities would need to have additional incentive to construct IGCC rather than boiler plants, and the cost advantage of producing fertilizers locally from coal rather than importing fertilizers produced from natural gas would need to be demonstrated. MCED and the Department of Commerce can prepare for such events and demonstrate the feasibility of the concept. A steering committee of representatives from government, researchers on both fertilizer use (NDSU) and IGCC fertilizer production (EERC), industry partners, agriculture co-ops, transportation firms, and local development officials, could guide this effort.

> *Next Steps: MCED and Commerce could lay the groundwork for additional fertilizer production in Coal Country by gathering a steering committee of potential players to examine the opportunities and challenges of transitioning to IGCC. If additional fertilizer production capacity appears attractive, MCED and Commerce could encourage industry partners to transition to IGCC whenever possible. This could include pursuing state and federal legislation to make IGCC more attractive. As background research, MCED and Commerce could also meet with the primary national players in this industry to gauge their interest in North Dakota. For example, why did Rentech choose to pursue a plant in Illinois rather than North Dakota?*

Figure 48: Development Roadmap: Fertilizers



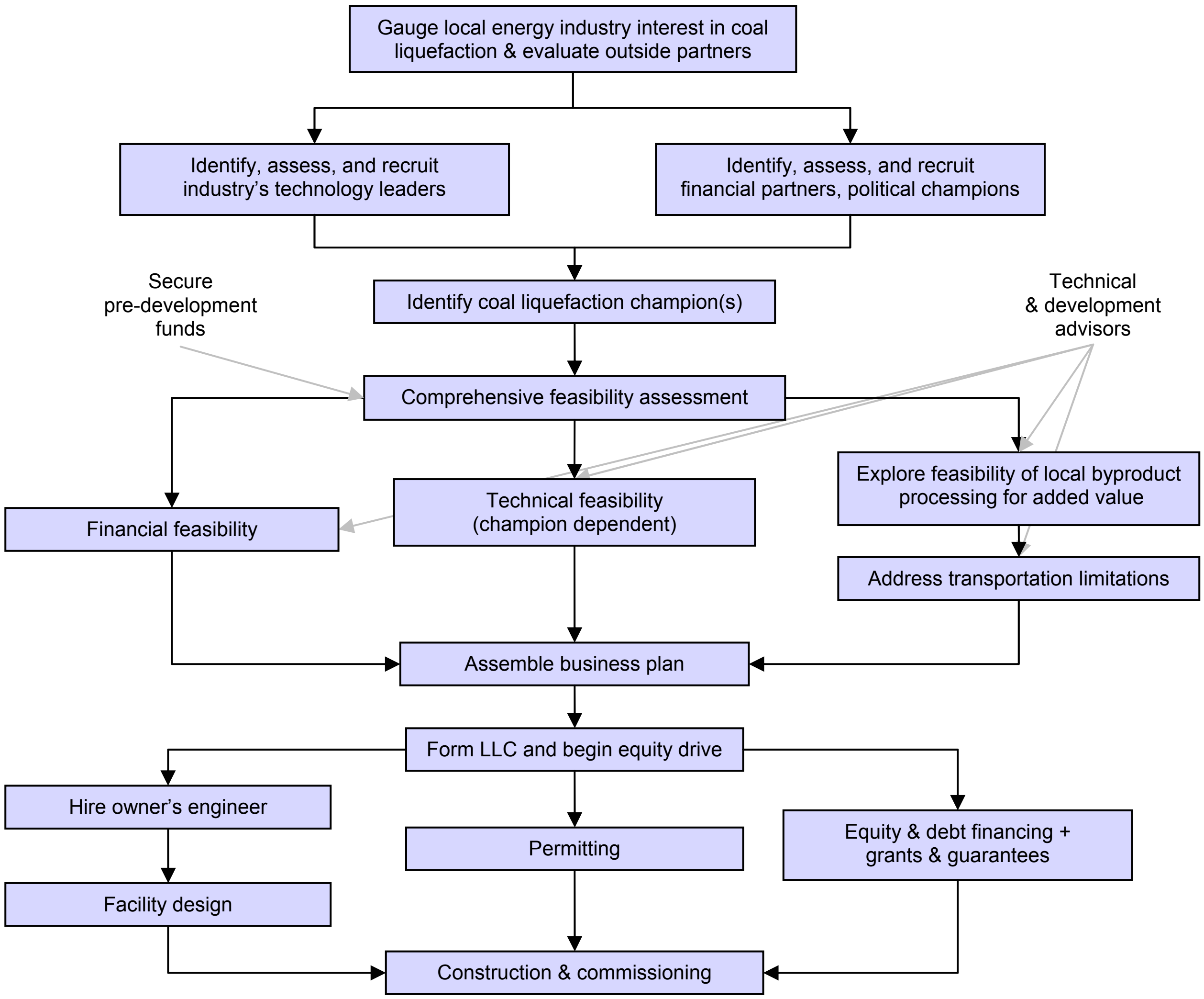
6.2.5. Coal Liquefaction

The generalized roadmap for development of a coal liquefaction facility in Mercer County is largely a business development process, but one that will require significant public sector input and partnerships. Generally a project developer would involve recruiting a steering committee of private and public sector representatives, identifying and assessing technology leaders, securing predevelopment funds, and conducting a comprehensive feasibility study. If deemed feasible, a business plan will be prepared by the private sector partners. Financial or strategic investors will be sought, and the comprehensive design and permitting of the facility would commence. Private sector partners will lead most of these steps. Therefore, it is likely that MCED and the Department of Commerce will best serve as facilitators for this process rather than leaders. The Department of Commerce has already done excellent work in this regard. By seeking input from all industry players through previous meetings Commerce has gauged interest and taken significant steps toward identifying companies that could champion this project.

However, given the goal of this report, and the nature of coal liquefaction, we would be remiss not to also recommend that State officials urge the project developers to enhance the project's value by processing locally as much as economically feasible the byproducts from coal liquefaction. ND DOC can provide consistent encouragement, targeted development assistance and could go so far as to tie a level of local byproduct processing to specific public sector support.

Next Steps: Having already gauged interest and identified industry champions, Commerce should continue to play a supporting role. Communicating with industry partners to offer assistance with state and federal legislation will be crucial. Most importantly, MCED and Commerce should insure that industries which use coal liquefaction byproducts locate in Coal Country. Again, collaboration with industry champions will be crucial to this effort, but MCED and Commerce can work independently to address existing barriers to local byproduct use. For instance, the transportation costs on the BNSF railroad make Coal Country less attractive to many industries. In summary, MCED and Commerce should be sure to treat the development of a coal liquefaction facility in North Dakota as a prime opportunity to develop numerous local down-stream industries, not a one-off project.

Figure 49: Development Roadmap: Coal Liquefaction



6. Conclusions and Recommendations

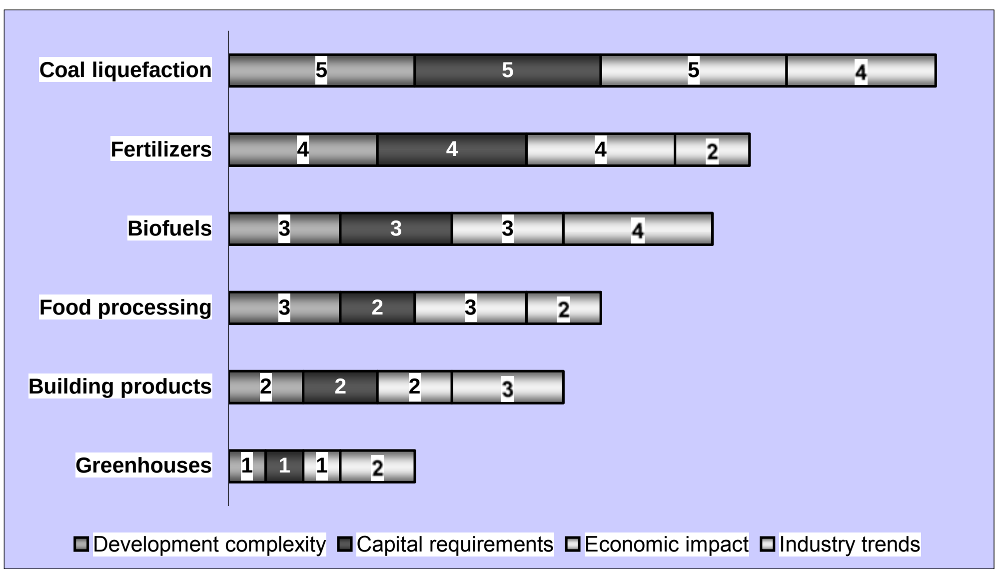
6.1. Ranking Industry targets

While all of the industries examined from development concept through roadmap deserve further attention, it is worthwhile considering the following factors to determine how to allocate the finite human resources available to the Coal Country Development Initiative:

- Human resource requirements (skills, quantity) for project development
- Capital resources (quantity and availability) requirements
- Long term economic impact
- Expansion and/or complementary business development opportunities
- Timeline to bring project to fulfillment
- Current industry attractiveness and trends

In careful consideration of the above, the project team recommends pursuing a multifaceted economic development strategy that is further detailed in the Section 6.5 Division of Responsibilities. This strategy involves moving forward immediately to develop short timeline, low complexity and low cost projects while simultaneously advancing the prospects of one or more long timeline, high investment projects that promise high economic return to the communities of Coal Country. The industries that are considered short term prospects include greenhouses, building materials and possibly food processing. Biofuels are considered a medium term prospect, while coal liquefaction and possibly fertilizers are considered longer term, high investment and high value initiatives. As is described in Section 6.5, Mercer County Economic Development is best positioned to lead the development efforts to achieve the short and medium term projects, while the North Dakota Department of Commerce is well suited to championing the longer time horizon, more capital intensive projects. Biofuels is one development prospect where a truly shared leadership effort is warranted.

Figure 50: Complexity, Investment, Impact of Industry Prospects



6.2. Marketing and Promotion

While marketing recommendations are provided in the previous roadmaps section, it is important to emphasize a few tactical concerns. Purposefully, the Coal Country Development Initiative has been a local affair with minimal exposure outside the region. The Initiative's stakeholders, particularly the North Dakota Department of Commerce and Mercer County Economic Development, should commit to maintaining this low profile until a comprehensive promotional strategy is conceived and basic promotional materials are considered market ready. The key items that must be in place include a website, basic print materials, and a developed program for prospect management and communications. The website and print materials must demonstrate the competitiveness of the project, be user-friendly and creative, and contain sufficient relevant technical information. Carefully managing the first impressions of prospective industries and business development partners will be crucial.

In addition, it will be important to agree in advance with the existing Coal Country energy industry partners as to the protocol for communication and interaction with development prospects. Interested energy industry partners should be well briefed prior to interaction with prospects and can be expected to develop partnership proposals that can be compared with competing locations within Coal Country.

6.3. Initiative Champion

North Dakota's Coal Country offers a unique opportunity to leverage vast existing resources for new economic development. First, the natural resources of the region are underutilized, leaving plenty of value to be captured from excess energy, materials, and water. Second, the high pay of many of the region's industrial jobs creates a relatively affluent population with disposable income. Third, the lack of jobs available for individuals brought to the region by spouses working in the industrial facilities creates a willing labor force. With these factors and more encouraging the growth of economic development through industrial symbiosis, Coal Country offers great promise.

However, as is always the case, political and cultural issues offer very real stumbling blocks to the success of this project. Projects initiated by the public sector often struggle if they cannot find a local representative to champion their goals and maintain momentum. This is due to the challenges in encouraging private players to collaborate, share information, and overcome competitive histories. In Coal Country, this stumbling block is particularly relevant. While both MCED and North Dakota Department of Commerce representatives see great value in pursuing this initiative, neither is currently able to commit the necessary human resources to achieve comprehensive success.

Solving this familiar predicament requires a dedicated individual working full time to champion this Initiative on behalf of MCED or by leading a new organization. This project champion should reside in Mercer County and would leverage and organize the human resources available in local government, ND DOC and other state agencies, local industry, and private sector development organizations like the Lignite Council. John Phillips, the lead economic development officer for the County, has expressed interest in this role. His experience and established relationships would prove extremely valuable, although such a role would require relinquishing all other non-project related duties that John currently performs. If these unrelated responsibilities can be conveyed to others, we would support John assuming the project champion role. If this is not possible, we recommend that MCED identify funding (including from local industry) to hire a dedicated project champion that will work alongside John.

6.4. Community Development

This report describes opportunities to make the best possible use of the resources native to Coal Country. In addition to combusting and gasifying coal to produce electricity and syngas for export, the region can extract local value from the surplus heat, the ash, and the electricity itself. The same concept can apply to community development programs across Mercer County. Rather than paying a worker's salary and encouraging him or her to export those earnings to pay a mortgage, go shopping, and seek entertainment outside of Mercer County, MCED should help keep these salary dollars in the community. By making the best possible use of local financial resources, Coal Country will maintain control over its own development and suffer from fewer boom and bust cycles of development. This section provides justification for locally focused development and recommendations on how to achieve it.

The presence of three investment firms on Main Street in Beulah provides proof that residents have surplus income to invest. Interviews with numerous community members have confirmed that residents of Mercer County are hesitant to invest their money in the community. They believe they can earn higher returns elsewhere. A cultural change will be necessary to encourage community members to seek profits by investing in businesses on Main Street and elsewhere in the region.

Interviews have also confirmed that there is a need for additional spousal employment in the local communities. Numerous employees at local power plants live outside of Mercer County because their spouses are unable to find employment within Coal Country. Reinvesting capital in the local community would promote local business development and increase the diversity of employment opportunities.

Interviews have also revealed that many residents believe a real estate investment in Mercer County is a poor financial decision. Power plant employees are willing to spend many hours commuting in order to earn higher returns on a property investment in Bismarck. An aggressive local community development effort is likely to improve the return that people are able to earn on their property in Coal Country as properties become more competitive with Bismarck.

Finally, a reinvestment in the local economy will make it far easier for local industries to recruit and retain staff and for economic development personnel to attract new industry partners to the area. Like the unused industrial resources of Coal Country, the Main Streets of the local towns hold considerable unrealized opportunity. The need for a facelift of Beulah's Main Street businesses is evident to visitors. The capital for such a project is available in Coal Country, and the benefits to local residents in terms of quality of life, to local businesses in terms of greater returns, to local industries in terms of staff recruitment and retention, and to local government in terms of increased tax revenue would be substantial.

The community development effort could involve three major steps. First, a marketing or community development effort could change attitudes regarding investing in the community. The following is one possible example. People frequently use the saying, "Keep 'em home," to refer to the need to keep the youth of North Dakota in state. MCED could send out bumper stickers in water bills that remind people to "Keep 'em home," in this case referring to their dollars. This mailing could include a few short statistics regarding the impact of dollars spent locally, For instance, every one dollar spent in a local independent shop has the same economic impact as three dollars spent in a national chain located in the same town. A dollar spent in Bismarck barely registers any economic return to Mercer County. The back of the bumper stickers could have another tag line, for instance, "Mercer County businesses give you better quality for your money and add value to our communities." Local businesses and industry partners could be encouraged to fund this very low-cost promotion.

Second, MCED could promote a culture of entrepreneurship in Mercer County. Such activities could include sponsoring workshops on small business ownership arranged by the North Dakota Marketplace for Entrepreneurs, promotion of specific Main Street businesses along highways 200 and 49 (signs listing specific businesses rather than simply pointing the way to the "Business District"), and even coordinating technical assistance to improve the management capacity of entrepreneurs.

Third, MCED could approach local banks, investment firms, and industry partners to create a community development investment fund. A common investment tool that earns similar returns to low-risk bonds, a community development fund could diversify and stabilize investors' portfolios. The fund could be used to provide loans to local businesses for façade improvements or to invest in new local enterprises. Numerous examples of such funds exist across the country. These include Community Reinvestment Fund (Minneapolis, MN), First Community Credit Union (Jamestown, ND), Community Economics (Boston, MA), and even venture capital funds focused on rural areas making use of technology like Village Ventures (Williamstown, MA). The community investment fund should attract the involvement of local industry partners by building a strong case for the positive return that such improvements and business development would have in their staff recruitment and retention.

If MCED chooses to pursue these recommendations, it would be easy to fall into two traps. First, it would be easy to focus on the added value of community investment without focusing on the high level of quality and service received at local businesses. People shouldn't shop in Mercer County simply out of a sense of obligation; they should shop close to home also to find better products and services. Second, it would be a mistake to promote of sense of insularity, isolationism, or provincialism. People shouldn't invest in Mercer County because Mercer County is trying to separate itself from the rest of the world. Instead, a community investment project should demonstrate that Mercer County is trying to engage in the global economy on its own terms.

In summary, the communities of Mercer County hold unrealized opportunities. A great deal of value currently remains uncaptured. The residents and employees of Mercer County must reexamine their local communities and realize the benefits of local investment and local consumption – adding the greatest value possible to their local intellectual, cultural, and natural resources.

Community Development Recommendations

- Community marketing effort: "Keep 'em home" promotion
- Entrepreneurship promotion: workshops and incentives
- Community investment fund: coordinate with local banks and industries
- Avoid pitfalls: focus on quality, be proud of what you have, and engage in global marketplace
- Redesign, simplify, and improve the content of www.beulahnd.org.*

* This website will be an important complement to the web-based promotional effort of the Coal Country Development Initiative and deserves similar attention.

6.5. *Division of Responsibilities*

The Coal Country Development Initiative has numerous supporters. Unfortunately, this advantage can also be a hindrance if participants are uncertain of their responsibilities. In order to avoid this pitfall and make best use of everyone's skills, the following is a recommended division of responsibilities between Mercer County Economic Development (MCDC) and the North Dakota Department of Commerce.

MCED	ND DOC
• Overall project leadership	• Provide technical & logistical support to MCED
• Lead pursuit of partners in greenhouse and food processing industries	• Lead pursuit of partners in coal liquefaction, biofuels, building products, and specialty chemical industries
• Secure funds for marketing materials and dedicated project champion	• Utilize expertise of consultants in pursuit of these larger industry partners
• Hire and consult with design firm to produce marketing materials	• Insure that ancillary industries to liquefaction and IGCC are located in-state
• Recruit and hire project champion	• Include CCDI materials in general marketing efforts of ND DOC (mailings, advertisements, links on website, receptions, etc.)
• Should use contact with ND DOC and other government officials to demonstrate ease of working with government	• Involve MCED and industry partners in discussions with these industries as soon as possible

While these recommendations represent a shift of control from the state to the county, the authors believe that this is necessary to properly champion this regional Initiative, secure the support of the local energy industry and best exploit the comparative advantages of the two organizations.

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