

**LMFS-5 (RFP-92-3)
UPGRADED LIGNITE MARKET ASSESSMENT STUDY**

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CONTRACT AMOUNT: \$35,000

Project Schedule – 1 Year

Contract Date – 8/27/92
Start Date – 8/27/92
Completed – 6/10/93

Project Deliverables

Status Report – 9/30/92 ✓
Status Report – 11/30/92 ✓
Draft Final Report – 1/21/93 ✓
Final Report – 6/10/93 ✓

OBJECTIVE / STATEMENT OF WORK

The objective of this study is to identify potential purchasers of upgraded North Dakota lignite (UNDL) and to estimate future demand for upgraded lignite. The work to be performed was an assessment of the potential market for UNDL as a boiler fuel in Minnesota, Wisconsin and Europe. The owners and operators of existing facilities were surveyed to determine:

- 1) sulfur content of their current fuel,
- 2) if switching to a low sulfur coal is an option,
- 3) derating of the plant with a Powder River Basin (PRB) coal,
- 4) specifications for a substitute fuel, and
- 5) specifications for a blended fuel.

STATUS

This study draws on the two companion studies LMFS-3 (RFP-1), “Lignite Upgrading Feasibility Study”, and LMFS-4 (RFP-2), “Lignite Transportation Study”. The first of these studies provides fuel quality and cost information for the most promising upgrading processes. The second study provides cost information for transporting the product to market. These studies were used to develop specifications and delivered cost for two UNDL product specifications. The quality and delivered cost for these two products is summarized for the Great Lakes and Europe in the table on the following page.

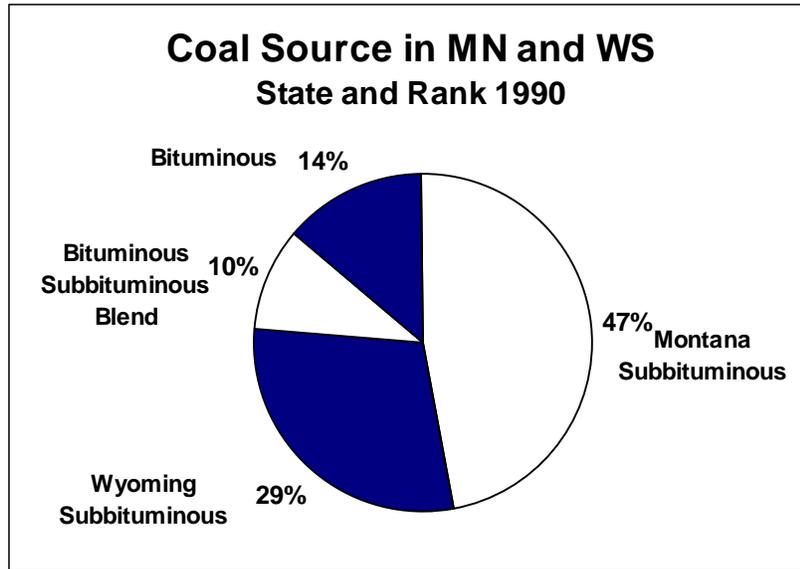
Minnesota and Wisconsin Summary

The best case delivered cost of the UNDL with product 1 specifications to Minnesota is about \$25 per ton (\$1.24/MMBtu) and cost of the product 2 in Minnesota is about \$37 per ton (\$1.69/MMBtu). Product 1 delivered cost in Wisconsin is about \$28 per ton (\$1.44/MMBtu) and product 2 about \$40 per ton (\$1.87/MMBtu).

Delivered Costs of Upgraded Lignite – An Estimation

Characteristic	Basis	Unit	Product 1	Product 2
Process Type			Thermal Drying	Hydrothermal Drying
Type of Material			Lumps & Briquettes	Briquettes
Total Moisture	As-received	wt %	10	10
Ash	As-received	wt %	7.6	7.3
Volatile Matter	As-received	wt %	44.2	36.0
Fixed Carbon	As-received	wt %	38.5	46.7
Total	As-received	Btu/lb.	100	100
Heating Value	As-received	wt %	9,900	10,800
Sulfur	Moisture free	wt %	1.2	0.7
Sulfur Emissions		lbs. of SO ₂ /MMBtu	2.2	1.2
Na ₂ O in Ash		wt %	4.9	2
Moisture Absorption	Comparison	Subbituminous Bituminous	Subbituminous	Bituminous
Spontaneous Combustion	Comparison	Subbituminous Bituminous	Subbituminous	Bituminous
Size Degradation	Comparison	Subbituminous Bituminous	Subbituminous	Bituminous
Bulk Density	As-received	lb./ft. ³	38 – 42	45 – 50
Mining Costs	As-received	\$/ton	6 – 7.5	6 – 7.5
	As-processed	Range	9 – 11.25	10.80 – 13.50
Processing Costs	Range	\$/ton	11.29 – 14.26	21.38 – 25.70
	As-processed	\$/MMBtu	0.57 – 0.72	0.99 – 1.19
Transportation Costs	Great Lakes	\$/ton	4.28 – 8.18	4.28 – 8.18
	Range	\$/MMBtu	0.22 – 0.41	0.22 – 0.41
Delivered Costs	Great Lakes Range	\$/ton	24.57 – 33.69	36.46 – 47.38
		\$/MMBtu	1.24 – 1.70	1.69 – 2.19
Transportation Costs	Rotterdam	\$/ton	23.19 – 35.12	23.19 – 35.12
	Range	\$/MMBtu	1.17 – 1.77	1.17 – 1.77
Delivered Costs	Rotterdam Range	\$/ton	43.38 – 60.63	55.37 – 74.32
		\$/MMBtu	2.20 – 3.06	2.56 – 3.44

The report summarized published information on the Minnesota and Wisconsin coal utility market at the end of 1990. Coal consumption in 1990 for Minnesota was 16,885,589 tons and for Wisconsin was 18,230,191 tons. As shown in the following chart, 80% of all the coal consumed in Minnesota and Wisconsin is supplied by Wyoming and Montana.



The range and average coal quality and prices for the coal consumed in Minnesota and Wisconsin during 1990 is summarized in the following table.

Characteristic	Unit	Minnesota		Wisconsin	
		Range	Average	Range	Average
Sulfur	wt %	0.25-1.96	0.69	0.35-2.12	1.34
Heat Content	Btu/lb.	8571-12269	8709	8441-13772	9575
SO ₂ Emissions	lbs./MMBtu	.58-3.51	1.25	.81-3.83	1.65
Delivered Cost	\$/ton	18.28-42.58	21.91	18.13-53.05	26.58
Delivered Cost	\$/MMBtu	1.05-1.77	1.26	1.07-2.03	1.39

This and other information found in the report were used to project market opportunities for UNDL.

The report identified four areas where opportunities exist for upgraded lignite to enter the utility coal market in Minnesota and Wisconsin. Specific potential purchasers were identified. However, each specific opportunity is subject to delivered costs, fuel specifications, fuel acceptance (testing and evaluation), and marketing efforts.

- Upgraded lignite as a blending stock – Upgraded lignite would be blended with high sulfur bituminous coal to meet sulfur emissions regulations. The upgraded lignite would be competing with low sulfur subbituminous and bituminous coals.
 - Minnesota – 900,000 tons per year
 - Wisconsin – 2,500,000 tons per year

- Upgraded lignite as a premium primary fuel, replacing high sulfur bituminous coal – Upgraded lignite would be used as a replacement for those units using high sulfur coals. The upgraded lignite would be a compliance coal allowing utilities to meet sulfur emission regulations.
 - Minnesota – 164,000 tons per year
 - Wisconsin – 4,500,000 tons per year

- Upgraded lignite as a primary fuel, replacing subbituminous coal – Upgraded lignite would be used to replace subbituminous coal currently burned in Minnesota and Wisconsin.
 - Minnesota – 140,000 tons per year
 - Wisconsin – 3,500,000 tons per year

- Upgraded lignite as a specialty fuel – Upgraded lignite has shown very favorable reactivity during combustion and has the potential to be used as a coal water slurry replacing oil or for reburn to control NO_x in boilers. Currently, a demand or opportunity for this particular market sector does not exist.

The report recommends continued development and marketing of an upgraded lignite for use by utilities in Minnesota and Wisconsin. It is recommended that upgraded lignite be developed and marketed as a blending stock replacing high sulfur bituminous coal. The following general tasks were recommended:

- development of a product name, specifications and timing for entry into the market,
- development and testing of the prototype fuel,
- development of a potential customer database and marketing plan, and
- initiate customer visits and maintain contact with potential customers.

Europe Summary

An effort was made to duplicate the study/survey done with utilities in Minnesota and Wisconsin with specific potential customers in Europe. Issues dealing with coal mining subsidies in Europe have made fuel supply forecasting a highly sensitive issue. A general assessment of the European steam coal market was made to determine the important parameters affecting the introduction of upgraded lignite into Europe. Using this method, specific countries were identified where there are potential opportunities for an upgraded lignite. Based on the companion studies, an upgraded lignite would be competitive with an upgraded PRB. However, an upgraded lignite would have to compete with coals that generally have a higher heat content.

The recommendations for marketing an upgraded lignite to Europe were generally similar to those for Minnesota and Wisconsin. Given the severe competition from other world markets, cost savings and product specifications must be improved.