AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Staff Paper Series

Staff Paper P76-8 February 24, 1976

ENVIRONMENTAL-ECONOMIC IMPACTS OF CANADIAN CRUDE OIL CURTAILMENT ON MINNESOTA

Wilbur R. Maki and Jawaid U. Elahi
University of Minnesota

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture, Forestry, and Home Economics
St. Paul, MN 55108

P76-8 February 24, 1976

ENVIRONMENTAL-ECONOMIC IMPACTS OF CANADIAN CRUDE OIL CURTAILMENT ON MINNESOTA

Wilbur R. Maki and Jawaid U. Elahi
University of Minnesota

Staff papers are published without formal review within the Department of Agriculture and Applied Economics.

ENVIRONMENTAL-ECONOMIC IMPACTS OF CANADIAN CRUDE OIL CURTAILMENT ON MINNESOTA[1/]

Wilbur R. Maki and Jawaid U. Elahi

Curtailment of Canadian crude oil shipments to the U.S. northern land-locked areas is likely to impact adversly the economy and the quality of life in Minnesota and Wisconsin in future years. Businesses which now depend heavily on Canadian crude exports will be most severely affected by the scheduled crude oil curtailment. Included among these businesses are the four oil refineries in the two states, plus one refinery in North Dakota.

The four refineries serving the Minnesota economy depend almost wholly on the Canadian supply source. They employed a total workforce of 855 persons and reported an average daily refinery run of 216,837 barrels in 1974 (table 1). Slightly more than 80 percent of the total refinery run was utilized in Minnesota, which in turn accounted for about 65 percent of the total petroleum products utilized in the State. The remainder of the refinery run was utilized in Iowa, Wisconsin, North and South Dakota, and the Upper Penninsula of Michigan.

Crude Petroluem

Available daily supplies of Canadian crude will decline from 215,000 barrels in 1975 to 100,000 barrels in 1978 and to only 10 percent of needed supplies beyond 1979. Without replacement supplies, operation of refineries located in Minnesota and Superior, Wisconsin is likely to be curtailed completely by 1979, or even earlier.

1/ Preliminary report and background statement relating to study proposal on "Economic Impacts of Petroleum Refinery Shutdown in Upper Midwest Region" prepared by David Braslau, Wilbur Maki, Herbert Mohring, Mike Murphy and Ernesto Venegas for use of Federal Energy Administration and other funding sources.

Table 1. Total Employment, Capacity, Average Run, and Related Statistics for Specified Petroleum Refineries, Minnesota and Wisconsin, 1974.

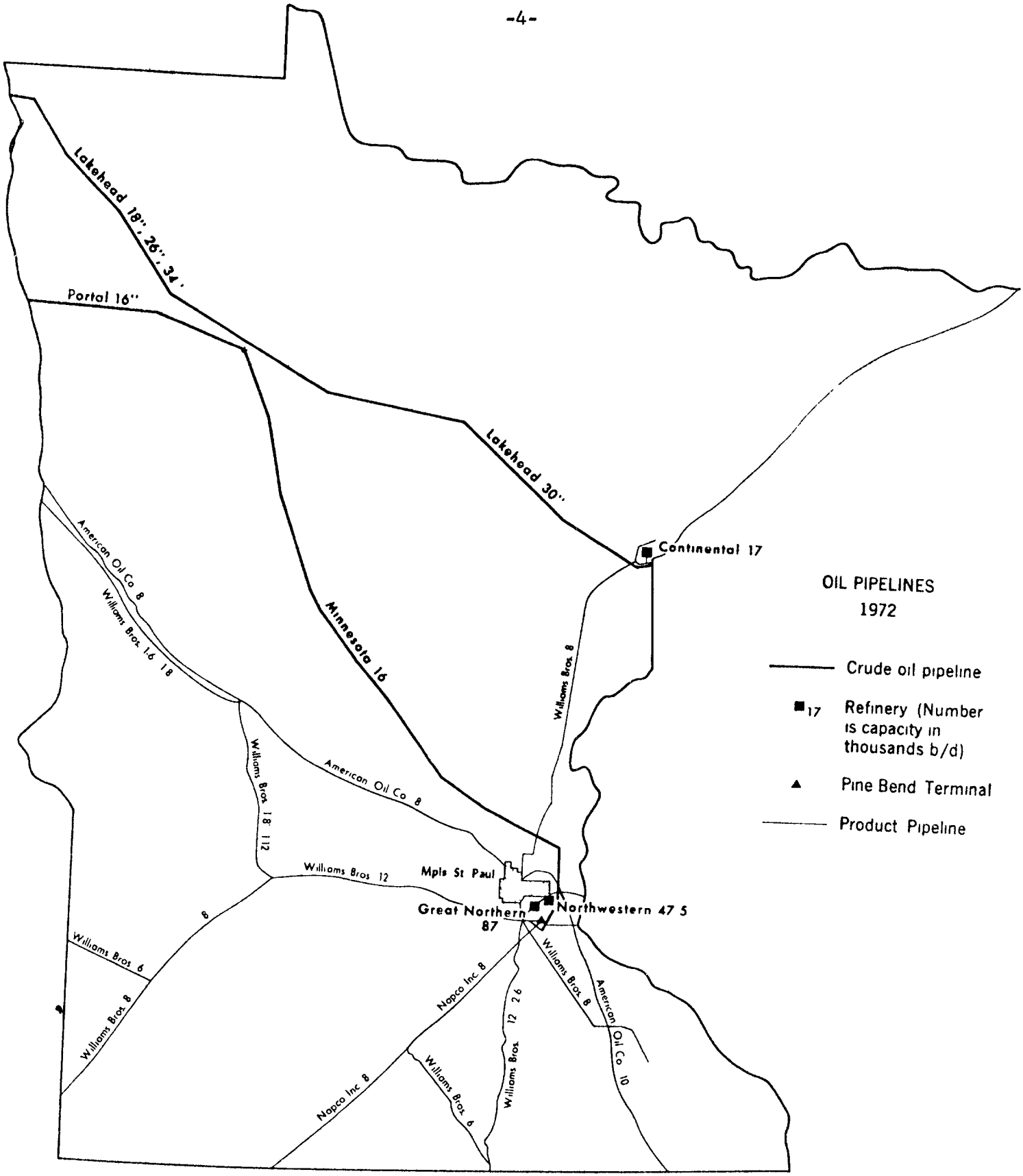
Refinery	Location	Employees	Refinery Capacity	Refinery Output: Average Daily Run	Refinery Output: Total Run	Total Production: All Products	Total Production: Gasoline and Distillates Delivered to Minnesota 1/
		(number)	(barrels)	(barrels)	(barrels)	(1,000 gallons)	
Conoco	Wrenshall, Minnesota	139	30,000	23,400	8,577,500	360,255	283,065
Ashland	St. Paul Park, Minnesota	165	65,000	65,000	23,725,000	996,450	597,870
Koch	St. Paul, Minnesota	400	135,000	99,887	36,558,617	1,535,462	841,850
Murphy	Superior, Wisconsin	151	40,000	28,500	10,402,500	436,905	159,734
Total		855	270,000	216,837	79,263,617	3,329,072	1,834,520

1/ Residual oil and asphalt products from four refineries total 229,314,979 gallons, which, together with gasoline and distillate, yield 2,063,834,815 gallons of petroleum products derived from Canadian crude which are delivered to Minnesota final users.

Source: Minnesota Energy Agency, 1975.

Since 1964, the two pipeline systems entering Minnesota from the North and West have provided the total four-refinery supply, except for a brief period recentlywhen crude oil was transported by Williams Brothers pipeline from Mid-Continent sources to Minnesota. The Portal 16-inch and the Lakehead 18-inch, 26-inch and 34-inch pipelines enter the State from Canada via North Dakota (Fig. 1). The Lakehead line, after its junction with the Minnesota Pipeline at Clearwater, Minnesota, proceeds through northern Minnesota to Superior, Wisconsin. The Lakehead line splits at Superior with the 34-inch South line going to the Chicago area and then across Michigan (as a 30-inch line) to rejoin the North line at Sarnia near the U.S.-Canadian border where it continues, finally, as the Interprovincial pipeline. The 30-inch North branch proceeds across the Upper Peninsula of Michigan to Mackinaw City and finally Sarnia. The total capacity of the crude pipeline system in Minnesota in 1970 was about 2.4 million barrels per day. However, the maximum amount of crude delivered to Minnesota has been less than 240,000 barrels per day (because of the large through shipments).

One supply replacement alternative is to pump U.S. Gulf Coast (or imported) crude to Eastern Canada via Chicago which is swapped for the crude from western Canada left in Minnesota. Another proposed alternative would make use of the Lakehead Interprovincial line for Alaskan crude pumped from Seattle. Barge transportation is still another alternative for supplying the Twin City refineries over a nine-month period (including one month from storage). An equivalent of slightly more than two tows per day would be required to supply the two refineries. Pipeline and rail transportation would be required for at least three months each year.



Source American Petroleum Institute

Minnesota Energy Project

Petroleum Products

Petroleum products are transported to Minnesota by pipeline, barge, rail and truck. Product pipeline capacity for Minnesota in 1970 was about 150,000 barrels per day. About one half of the 2,671 miles of petroleum pipelines are for petroleum products. Two Williams Brothers pipelines enter the State from Kansas City via Sioux Falls, South Dakota and Albert Lea, Minnesota. A Napco (8-inch) pipeline enters the State, also, from Mid-Continent refineries. Finally, the American Oil Co. (10-inch) pipeline through Southeast Minnesota originates from the Indiana-Illinois refineries.

Pipeline transportation rates vary by product and distance. Crude petroleum is shipped from Humboldt, Kansas to the Great Northern refinery at Pine Bend, Minnesota for 60 cents a barrel. Petroleum product rates are higher than crude petroleum rates. However, weight loss occurs in refining which makesa 71 cents per barrel product rate more nearly equivalent to the 60 cents crude petroleum rate.

Barge transportation, although more costly than pipe transportation, is used to meet total petroleum product (but not crude petroleum) requirements in Minnesota.[2/] In 1971 the inbound transportation of products (for ports above Lock and Dam 2 and on the Black River) was over 10 million barrels (Table 2). Much of this tonnage was shipped to Minmesota, which, together with the petroleum products moved by pipeline and obtained directly from the four refineries identified earlier, account for the entire product supply in the State.

2/ Crude petroleum had been shipped by barge to St. Paul prior to 1964, but economic access to Canadian crude supplier via the Lakehead pipeline provided a replacement for the higher cost shipments. Also, small quantities of crude have been transported from North Dakota fields via the Portal pipeline and, in 1975, by barge from Gulf Coast sources.

Table 2 Estimated utilization and barge transportation of petroleum products, Minnesota, 1971[1/]

Product	Estimated Total Utilization in Minnesota	Inbound barge[2/]	Outbound barge	Inbound barge as a proportion of total utilization in Minnesota
	(1,000 barrels)	(1,000 barrels)	(1,000 barrels)	(percent)
Gasoline	48,361.9	7,652.7	269.4	15.8
Distillate Oil	23,776.9	2,064.5	144.6	8.7
Residual Oil	2,783.5	123.9	126.4	4.5
Liquid Propane Gas	9,780.9	--	--	--
Kerosene	1,393.2	666.4	--	47.8
Jet Fuel	4,000.0	456.6	039.4	11.4
Total	90,096.4	10,964.1	579.8	12.2

1/ For ports above lock and Dam 2 and on the Black River

2/ Inbound barges, which typically are hauled in tows of eight or more barges, are of two sizes -- 50 by 290 feet and 3,000 tons capacity and 35 by 195 feet and 1,500 tons capacity. Size of barge tow is limited by size of power unit and locks (which, on the Upper Mississippi River, are 110 feet wide and not less than 1,000 feet long). Refinery unloading facilities, however, rather than tow capacities, are the shortrun limiting factor in restricting barge transportation of crude oil.

Barge transportation charges for petroleum products from Chicago refineries averaged about 70 cents per barrel in 1971, exclusive of related handling and shipping costs which must be included for comparison with pipeline transportation costs. These charges would be higher today than five years ago.

Receipts by barge of petroleum products increased slightly from 1971 to 1972 but declined from 1973 to 1974. However, larger percentage changes have occurred in the product composition of receipts presumably because of changes in both demand and supply conditions.

Relative transportation costs for petroleum products are compared for barge, rail, and pipeline (Table 3). Pipeline costs generally are two-thirds or less, of corresponding barge costs, while the latter are one-third or less than the cost of rail transportation. Except for short hauls, truck transportation is prohibitively costly.

Shipment of industrial fuels and and residual petroleum products (which are acquired largely from the local refineries for the local market) presents special transportation problems. Shipment of these products by barge or rail would be required, thus adding to their utilization costs in the Minnesota economy.

Economic Effects

Shut-down of the four refineries will have an immediate impact on both the local employment area and the Minnesota consumer market. The local impact would include the direct effects of refinery shutdown on employment and earnings and indirect effects on total economic activity in the local trade areas.

Table 3. Comparison of alternative rates per ton mile for crude petroleum and petroleum products shipped to Minnesota, 1975.

Product and origin	Destination	Receipts	Distance	Rates Per Net Ton Barge1/	Rail	Truck
		(tons)	(miles)	(dol.)	(dol.)	(dol.)
Gasoline						
Hartford, Ill.	Winona, Mn.	40197	456	3.59	11.80	32.72
Hartford, Ill.	St. Paul, Mn.	17345	524	3.81	12.00	38.27
Hartford, Ill.	Winona, Mn.	20362	689	5.04	12.60	---
Jet Fuel						
Hartford, Ill.	St. Paul, Mn.	38825	524	4.47	12.00	38.27
Kerosene						
Norco, La.	St. Paul, Mn.	7983	1210	6.64	17.80	---
Beaumont, Tex.	St. Paul, Mn.	4827	1209	8.60	17.60	---
Gas Oil, Fuel Oil						
St. Louis, Mo.	Winona, Mn.	3149	456	3.61	17.00	38.46
Hartford, Ill.	Mn. River, Mn.	2386	524	3.83	19.60	44.99
Beaumont, Tex.	St. Paul, Mn.	5264	1209	3.65	17.50	---
Residual Fuel Oil						
Hartford, Ill.	St. Paul, Mn.	5891	524	4.04	11.60	38.11
Beaumont, Tex.	St. Paul, Mn.	1376	1209	8.65	18.00	--
Lub. Oils & Grease						
Beaumont, Tex.	St. Paul, Mn.	16103	1209	9.53	17.20	---
Benzol & Benzane						
Hartford, Ill.	St. Paul, Mn.	2445	524	4.29	15.80	38.27
Crude Petroleum						
Humboldt, Kan.	Pine Bend, Mn.	N.A.	470	3.95	---	---
Unleaded Gasoline						
Kansas City, Kan.	St. Paul, Mn.	N.A.	402	4.51	---	---

1/ Direct hauling expenses only. Last two entries are pipeline rates only.

Source: Charles Donley and Associates, Formulation Evaluation Report, Locks and Dam No.26 (Replacement), Upper Mississippi River Basin, Mississippi River - Alton, Illinois, Design Memorandum No. 11, Volume II, Appendix I Rate Analysis, Appendix J Transportation Cost Analysis, U.S. Corps of Engineers, St. Paul District. March 31, 1975.

Local Impacts

Refinery lay-offs would include the nearly 900 employees noted earlier with estimated total earnings of more than $10 million (Table 4). Because of inter-industry linkages and delayed expenditure impacts, total regional employment could drop by 5,000, which would result in total regional payroll loss of more than $50 million (based on 1972-74 economic relationships). New employment opportunities for the displaced workers of course would dampen the severity of the economic impact. If the impact of energy shortages on specific industries were included, the employment and payroll losses would be substantially greater than projected in this analysis.

In addition, owners of the four refineries would incur certain business losses because of refinery shut-down. Business assets -- plant and equipment -- used in petroleum refining total approximately $200 million.[3/]

Regional Impacts

Statewide impacts include not only the local impacts from reduced employment and earnings and related business losses, but, also, the added cost of petroleum products as a result of higher transportation and marketing expenses. Assuming all replacement petroleum products were to originate from the Chicago area refineries, the average product price would not change appreciably under current market conditions.[4/] If

---

3/Replacement costs, of course, are much higher than the estimated asset losses, as noted later.

4/Price competition is fostered by the existence of alternate product and supply sources, including the four regional refineries. Unit price paid by the Minnesota consumer is determined by production and input costs and margins incurred in moving product to markets. Hence, the equivalent consumer purchase price is likely to remain about the same regardless of the form in which the product first reaches the point of utilization as long as the local refineries produce less than total local market requirements.

Table 4 Estimated Purchases, Sales and Inter-industry Effects of Petroleum Refining Industry, Minnesota, 1972.

	Industry	Total Inter-industry Transaction of Petroleum Refining Industry 1/		Total Inter-industry Effects Per $1 million Final Sales 2/		
		Purchases	Sales	Output	Employment	Payroll
		($1,000)	($1,000)	(dol.)	(no.)	(dol)
1.	Livestock & livestock prod.	0	4,496	1,300	018	33
2	Other agric. products	0	29,660	1,200	.106	40
3.	Agri services, for , fish.	0	157	100	.001	24
4.	Iron & ferro alloy ores	0	778	100	.001	13
5	Nonferrous metal ores	0	0	0	0	0
6	Other mining, quarrying	17,928	185	61,900	2 494	22,439
7.	Construction	4,116	32,564	20,600	405	5,183
8.	Food & kindred prod.	335	5,169	2,900	.030	277
9.	Lumber & furniture	0	1,223	1,000	052	433
10.	Pulp & paper products	1,799	2,493	11,300	229	2,133
11	Printing & publishing	30	532	3,500	127	1,389
12.	Chemicals & allied prod.	5,314	9,822	24,400	.332	2,746
13	Petroleum refining	10,667	10,667	1,038,800	4 429	70,326
14.	Stone, clay & glass	396	925	3,200	.090	603
15	Primary metals	117	290	1,800	.057	570
16	Fabricated metals	976	1,396	7,400	.235	2,158
17	Machinery exc. electrical	976	3,998	8,200	214	2,036
18	Electrical manufactures	97	572	2,600	076	790
19.	Other manufacturing	581	1,562	6,600	285	2,916
20.	Railroad transportation	671	5,208	4,200	.238	2,578
21.	Trucking & warehousing	700	4,198	3,300	371	1,284
22.	Other transportation	13,172	11,223	49,500	1.886	17,464
23.	Communication	253	765	3,400	.114	1,245
24	Electric utilities	1,189	2,853	6,100	086	874
25.	Gas utilities	2,440	108	12,500	.179	1,790
26	Other utilities	396	204	1,800	021	259
27.	Wholesale trade	2,451	9,389	12,300	.764	4,033
28.	Retail trade	91	8,340	2,000	235	572
29.	Finance, ins., real estate	8,842	12,085	48,900	685	6,484
30.	Hotels, pers & repair serv.	152	3,831	1,100	.067	287
31.	Business services	3,171	748	14,700	1 007	3,609
32.	Medical, educational	61	4,591	700	.049	340
33.	Other services	152	361	1,500	077	448
34.	Federal govt enterprise	183	1,322	1,700	094	1,278
35	State & local govt. ent.	0	3,380	5,600	554	1,202
	Total Inter-industry	77,257	175,100	1,367,300	15 620	157,856
	Primary or Final Minnesota	75,400	129,800	--	--	--
	Rest of Nation	152,242	0	--	--	--
	Gross Outlay or Output	304,900	304,900	--	--	--

1/ Intra-state purchases and sales are reduced by imports of crude petroleum and other refining inputs and also, by imports of materials and other inputs of supplying industries

2/ Includes indirect effects on industries supplying inputs for Minnesota petroleum refining industry

Source E C Venegas, W R Maki and J.E Carter, A 1972 Structural Model of the Minnesota Economy Towards a Policy-Oriented Tool, Research Division, Minnesota Energy Agency, St Paul, Minnesota, April, 1975

current excess refinery capacity and available petroleum product supplies were to disappear, then the consumer market price would change, also, because of related changes in marketing margins and market distribution of petroleum products. Thus, the Minnesota petroleum product market is extremely vulnerable to adverse changes in both market organization and supply conditions.

The economic vulnerability of the petroleum-dependent activity in Minnesota is represented by the discounting of future business investment and location plans. This discounting occurs because of perceived market re-organization impacts stemming from the replacement of several local supply sources with more distant sources controlled by an even more distant management. From a national perspective, the Upper Midwest petroleum market often times suffers from an "end-of-the-line" characterization on the part of national product suppliers.

Finally, if the Minnesota economy were dependent on the Chicago area refineries for product supplies, both pipeline and refinery facilities in the Chicago area would require expansion in the near future. Facility expansion of course would require corresponding expansion of product pipelines from Chicago to Minnesota.Without pipeline expansion, barge and rail transportation would be required to ship approximately 90 to 100 million barrels of petroleum products. Using 1971 data and line haul rates only for barge, the transportation outlay would exceed $84 million (Table 5). This amount is nearly twice the outlay for an equivalent supply of crude petroleum in 1971 shipped by pipeline.

Based on pre-1972 prices, estimated investment expenses for a 200,000 barrel per day refinery would exceed $400 million (Table 6). Corresponding estimates today range from $3 to $7 million per 1,000 barrels per day capacity. New product pipeline investment requirements also would run

Table 5. Estimated Transportation Expenses for Specified Petroleum Products Shipped from Hartford, Illinois to Minnesota, 1971.

	Total Utilization	Average Density Per Gallon at 60°F	Transportation Expense Per Barrel Equivalent		Proportion of Yearly Utilization		Transportation	
			Barge 1/	Rail	Mar 15-Dec 15	Dec 15-Mar 15	Barge 3/	Rail
	(1,000 barrels)	(lbs)	(dol.)	(dol.)	(pct)	(pct)	($1,000)	($1,000)
Gasoline	48,362	6.0156	0.52	1.51	78	22	19,666	16,293
Distillate	23,777	7.1845	0.58	2.96	56	44	7,669	31,076
Residual Oil	2,784	7.7885	0.66	1.90	56	44	1,027	2,336
Liquid Propane Gas	9,781	4.2350	--	--	56	44	--	--
Kerosine 2/	1,3932	6.6840	1.06	2.48	56	44	831	1,529
Jet Fuel	4,000	6.0156	0.56	1.51	56	44	1,260	2,679
Total or Average	90,096	6.3205	0.67	2.06	67	33	30,453	53,914

1/ Excluding terminal costs for barge.
2/ From Norco, La. and Beaumont, Texas; all other fuels from Hartford, Illinois.
3/ Because barge line-haul rates are negotiated for each shipment and loading and unloading expenses for barge shipments are included in product price or absorbed by receiver, the barge and rail transportation expenses are not strictly comparable; they only are indicative of minimal transportation outlays, exclusive of intra-state shipments.

Table 6. Estimated investment and operating expenses for a 200,000 barrel per day petroleum refinery, PADII, 1972.

Item	Total
	(barrels/day)
Capacity	200,000
Crude Unit	206,279
Investment	(dollars)
On Site	240,879,000
Offsite	82,836,000
Effluent Control	5,466,000
Docks	27,130,000
Tankage (Crude)	10,396,000
Tankage (Products)	9,835,000
Catalyst	3,388,000
Royalty	3,209,000
Total Investment	383,119,000
Working Capital	60,596,000
Total Funds	443,715,000
Expenses (per calendar day):	
Crude Oil (Duty)	801,617
Butane	16,106
Refining	107,731
Total	925,454

Source: Factors Affecting U.S. Petroleum, National Petroleum Committee on Factors Affecting U. S. Petroleum, Washington, D.C., May 1973.

to several hundred million dollars.

The monetary outlay estimate could be entirely hypothetical, given the current uncertainty about crude petroleum supplies and the remoteness of the Minnesota market areas to the Midwest product supply sources. Distribution margins, because of competitive factors noted earlier, may exceed current levels and even overshadow completely anticipated increases in the total transportation bill.

Shut-down of regional refineries and removal of a dependable petroleum product source for Minnesota consumers thus can add significantly to the total marketing bill for petroleum products. Most important is the uncertainty which is likely to accompany a shift in supply sources for petroleum-dependent activities. Some Minnesota-based industries may find the added uncertainty sufficient reason to relocate close to major petroleum product sources.

Development Alternatives

Examination of the combined cost and uncertainty considerations associated with shifts in petroleum product sources for Minnesota comsumers leads initially, at least, to the conclusion that development of alternative crude petroleum sources for existing refineries is of the highest priority. In the short-run, existing pipeline facilities can be expanded for use in transporting crude petroleum from Mid-Continent sources to Minnesota refineries. Williams PipeLine Company currently can handle approximately 30,000 BPD of crude from Humboldt, Kansas to Pine Bend, Minnesota.[5/] This company has been batching crude to Pine Bend since September 1974. By expanding the existing system, the Williams PipeLine Company is prepared to handle additional crude on a dedicated basis which would require

5/Letter dated January 7, 1976 from J.M. Bohannon, Manager, Planning and Tarrif, Williams PipeLine Company, Tulsa, Oklahoma.

installation of capacity under three options, namely,

(1)80,000 BPD in a 12-month period,
(2)130,000 BPD in a 12-month period, and
(3)200,000 BPD in a period of 18 months.

Williams PipeLine Company officials indicate that each of the three options will require new capital on their part and some type of throughput agreement with the shippers to underwrite some or all of the investments. The transportation rate for crude petroleum would depend on the volume level and time period specified in the contract.6/

From a long-run viewpoint, Alaskan and northern Canadian petroleum fields may prove the most accessible and reliable supply source for the Northern landlocked refineries. Proposals to deal with near-future shortages which require investment in product or crude petroleum pipelines originating from Mid-Continent or Indiana-Illinois refineries would contradict this viewpoint. Specifically, the long-term proposals include:

1. A Trans-Mountain (reverse flow) pipeline from Vancouver to Inter-Provincial pipeline and thence, to Minnesota and other Northern landlocked refineries (at an estimated cost of $225 million).7/

2. A Trans-Canada pipeline from Prodhue Bay field to Edmonton and thence to Northern landlocked and other refineries (in cooperation with Canadian development efforts).

3. A Northern Teir pipeline from Washington to Minnesota (at a reported cost of $1 billion).

4. A Chicago-to-Upper Midwest pipeline to tap Mid-Continent or import oil supplies (at an estimated cost of $100 million).8/

6/ A minimal 10-year guarantee of 35,000 BPD or a total of 9 million barrels per year, and an alternate 20-year commitment of 135,000 BPD or a yearly $16 million total revenue for Williams PipeLine Company from the Minnesota refineries have been suggested. Transportation rate of crude would be about 5 cents below product rate in the first case while in the second case it could be as much as 15 cents below product rate.

7/ Minnesota Energy Agency estimates prepared September 26, 1975.

8/ Development of Great Lakes crude petroleum shipping, though restricted to tankers of approximately 9,000 tons capacity (which are currently being used to supplement pipeline transportation of crude petroleum), is a complementary alternative.

Clearly, none of the long-run options are available to relieve the uncertainties of impending energy shortages, particularly in crude petroleum. Reduction of natural gas supplies would aggrevate further the adverse economic and environmental impacts of crude petroleum cut-off to area refineries and thus add to pressures for short-term remedies.

Cut-off of both crude petroleum and natural gas supplies would force a massive shift in the use of coal, which, in turn, would have serious statewide environmental impacts. If fuel oil was available as an alternative energy source, the total statewide environmental impact would be lessened.[9/]

In summary, the economic impacts of petroleum refinery shut-down in Minnesota and Northern Wisconsin would include both private and public losses. While the private losses would be substantial, the public losses may be even larger, but they are not readily measurable. Even the public cost of higher product prices may vary over a very wide range--from a very small added cost to $100 million or more per year for approximately 100 million barrels of petroleum products. In addition, the environmental costs of large-scale industrial, commercial and residential conversion to coal-based energy sources, though significant, are difficult to even estimate currently, let along forecast for future years. Clarification of options and determination of their likely environmental and economic costs is, therefore, an essential first step in learning how to deal with likely effects of Canadian crude oil curtailment to Upper Midwest refineries.

9/ Report on "Air Quality Impacts Due to Reduction in Natural Gas Supply to Minnesota - 1980", by David Braslau, 11 February 1976.