CHAPTER 8

Transportation

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The existing transportation network in the West was generally adequate to move coal production from Federal leases and private tracts in 1980, although a number of specific bottlenecks have been identified, It will be asked to carry greatly increased quantities of coal in the future. The key link in this network is rail haulage, which handled about 61 percent of Western coal production in 1979 and is likely to originate even more in 1990. Most Federal coal leases are and will be served by rail. The principal constraint that may materialize in moving future production of leased coal to its markets is the willingness of the railroads to invest sufficient capital in time to satisfy demand for increased rail service from all shippers, including Federal coal. The mine-to-market transportation costs of Western coal range from about 10 to over 70 percent of delivered fuel costs and constitute an important factor in developing future demand.

Western coal is mined at a considerable distance from most of the ultimate demand it serves, usually electric utility demand, and is used in very large quantities at low unit cost. Coal production therefore creates a substantial requirement for inexpensive bulk transportation services, Western coal now represents perhaps one-third of all the freight moved in its principal market area.

Utilities are the chief consumers of coal. In 1979 they converted 90 percent of all Western coal production to electricity (table 66). New utility projects are subject to long-term planning, ideally for their entire useful lives. Coal supply, transportation, generating plant siting, and electric transmission are all coordinated, arranged, and fixed. The availability and cost of different modes of transportation will influence the final choices, and thereby shape the future market and transportation network for western coal,

The two most important ways of moving Western coal in 1979 were by rail and wire. Railroads originated* 61 percent of all Western coal production in 1979 (table 66). Most of this coal traveled more than 750 miles, and some was delivered to customers by water, Utilities can also choose to burn coal in nearby or mine-mouth generating plants and distribute the electricity to distant customers through high-voltage transmission wires, In 1979, 36 percent of all western coal production was hauled short distances by truck, tramway, etc., to local generating plants (table 66). Some of this power was consumed locally, but a substantial amount was transmitted over hundreds of miles,

Three major long-distance transportation corridors exist for Federal coal. powder River basin coal flows east by rail to utilities in the middle and upper Midwest. Some of this coal has penetrated Indiana, western Kentucky, and Ohio markets via the Ohio River (see ch, 5; fig. 26.) A second corridor flows from the basin south into Arkansas and Texas. This coal has been shipped entirely by rail, although a coal slurry pipeline is projected to carry 25 million tons per year from the basin to Arkansas on completion in the late 1980's. The third corridor originates in the tri-State area of New Mexico, western Colorado, and Utah. It moves west into Nevada and California. Coal traffic from the northern Rockies west to Oregon and Washington is beginning to increase. Another corridor from Colorado and Utah to southern California may emerge if an export market for Western coal develops in Asia.

Other transport modes will not soon challenge the railroad's dominant position in the transportation of Western coal. Economic and technical considerations restrict the transmission of electricity over distances much beyond 500 miles. However, higher

* Rail-originated coal includes: 1) coal hauled exclusively by rail; 2) coal that is transferred to river haulage; and 3) coal transferred for shipment on the Great Lakes.

Table 66.—Distribution of Coals (bituminous, subbituminous, and lignite) Produced in the Western United States During Calendar Year 1979 (thousands of tons)

	District of origin								
Method of movement[a] consumer use	Western Interior coal province[b]	Colorado and New Mexico[c]	Arizona, California, and New Mexico[d]	Idaho and Wyoming	Utah	North and South Dakota	Montana, Alaska, Oregon, and Washington	Western subtotal	U. S. total
United States									
Electric utilities	33,933	14,659	22,582	68,529	7,098	13,361	36,768	196,930	549,774
Coke plants	170	3,362	—	—	943	—	—	4,475	76,971
Other industrial	3,866	1,457	2,265	3,148	2,492	1,531	482	15,241	67,140
Retail.	89	66	1	188	182	47	99	672	1,908
Miscellaneous	18	19	2	5	37	38	706	825	66,771
Total[f]	38,076	19,563	24,850	71,871	10,753	14,977	38,055	218,145	762,564
United States all-rail									
Electric utilities	3,473	10,519	10,745	50,323	2,071	4,951	22,159	104,241	287,950
Coke plants	170	3,362	.	—	943	–	—	4,475	46,033
Other industrial	1,145	1,346	2,252	3,009	1,735	1,300	421	11,208	37,707
Retail sales	8	28	—	119	30	31	99	315	729
Total	4,797	15,255	12,998	53,451	4,778	6,282	22,678	120,239	372,420
River and ex-river									
Electric utilities	177	—	—	4,930	981	–	1,616	7,704	91,100
Coke plants	—	—	—	—	—	—	—	—	18,989
Other industrial	183	1	—	—	—	—	—	184	2,650
Retail sales	—	—	—	—	—	—	—	—	31
Total	360	1	—	4,930	981	–	1,616	7,888	112,771
Great Lakes									
Electric utilities	—	—	—	—	—	—	5,413	5,413	
Coke plants	—	—	—	—	—	—	—	—	
Other industrial	—	—	—	6	—	—	45	51	
Retail sales	—	—	—	4	—	—	—	4	
Total	—	—	—	10	—	—	5,459	5,469	20,919
Tidewater	—	—	—	—	—	—	—	—	4,881
Truck									
Electric utilities	9,272	4,140	5,622	5,158	2,186	3,746	—	30,124	78,005
Coke plants	—	—	—	—	—	—	—	—	3,674
Other industrial	1,278	109	13	134	758	26	16	2,334	21,862
Retail sales	80	38	1	65	152	16	—	352	1,107
Total	10,631	4,287	5,636	5,357	3,096	3,788	16	32,811	104,649
Tramway, conveyor and private railroad									
Electric utilities	21,012	—	6,214	8,118	1,860	4,664	7,580	49,448	77,875
Coke plants	—	—	—	—	—	—	—	—	1,081
Other industrial	1,259	—	—	—	—	206	—	1,465	1,465
Retail sales	—	—	—	—	—	—	—	—	—
Total	22,271	—	6,214	8,118	1,860	4,870	7,580	50,913	80,422

[a]Data may not add because of rounding.
[b]This province includes all of Kansas, Missouri, Texas, and Oklahoma counties of Coal, Craig, Latimer, Muskagee, Okmulgee, Pitt.sburg, Rogus, Tulsa, and Wagoner.
[c]Includes all of Colorado, and those counties in New Mexico not listed in footnote d.
[d]Includes all of Arizona and California, and the following counties in New Mexico: Grant, Lincoln, McKinley, Rio Arriba, Sandoval, San Juan, San Miguel, Sante Fe, and Socorro.
[e]Miscellaneous includes railroad fuel, Great Lakes vessel fuel, Great Lakes commercial docks, coal used at mines and sales to employees, and destinations and Consumer use not revealable, and exports.
[f]Includes exports.

SOURCE: Data taken from U.S. Department of Energy, *Bituminous and Subbituminous Coal and Lignite Distribution Calendar Year 1979* (Washington, D. C.: DOE, Apr. 21, 1980), table 1, pp. 7-11.

voltage transmission lines could increase the economic shipping distance of mine-mouth power, and bulk power is likely to be "wheeled" to more distant consumers in the future. Coal slurry pipelines can compete with railroads over some routes but all the projects presently proposed would carry less than half the coal railroads carry now.

Current Transportation Patterns for Western Coal

The distribution of Western coal production in 1979 between end uses and means of transportation is presented in table 66, Electric utilities consumed 90 percent of all Western coal (197 million tons). Of that amount, 104 million tons—or 53 percent of the utility-consumed coal—was hauled by rail; 4 percent by river; 3 percent via the Great Lakes; 15 percent by truck; and 25 percent by tramway, conveyor, or private railroad. Most of the utility-consumed coal that was moved by rail, river, and Great Lakes traveled at least 750 miles. The coal described as transported by water had to travel 500 miles or more by rail to reach a connecting point. The longest all-rail hauls are about 1,800 miles. Coal burned in mine-mouth plants and short-haul coal is typically moved by conveyor, truck, or private railroad. Much of the electricity produced by this locally burned coal is shipped by wire over distances up to several hundred miles. Coke plants used only 2 percent of the West's coal production in 1979, and all of that was hauled by rail. Other industrials consumed about 7 percent of Western coal, almost three-quarters of which was moved by rail, Fewer than 1 million tons was sold as a retail product or used for miscellaneous purposes. Railroads moved 55 percent of Western coal output exclusively, and connected with water for an additional 6 percent.

Table 67 presents origin and destination data for Western coal production in 1979 by district of origin and State of destination. In this table, destination means where the coal was consumed, not where resulting electricity may have been consumed. Thirty States consumed Western coal in 1979. Table 68 displays dependence on Western coal for each of the 30 States. The degree of dependence not surprisingly was related to the distance from the Western coalfields: the further the consumer market, the less dependency on Western coal. Western coal's penetration into Ohio, Indiana, and Illinois has been related to sulfur-emission standards, which make Western low-sulfur coal attractive despite the distance and the cost. This market should continue for older plants, but new source performance standards (1979) may make local coals more attractive to utilities in these States.

Table 69 ranks these 30 States according to how much Western coal each consumed in 1979, Texas was by far the largest consumer; more than half of its consumption was mined locally and shipped a short distance. However, the powder River basin shipped about 11.6 million tons to Texas by rail. Most of the 16 million tons that Wyoming consumed was mined locally, for customers such as mine-mouth plants, All of Illinois' 15,2 million tons was shipped by rail, most of it from Wyoming and Montana. Most of Minnesota's 12.8 million tons was hauled by rail from Montana. Kansas, Iowa, and Nebraska tapped the powder River basin via rail for their coal. North Dakota used mostly locally mined coals. Colorado and Arizona consumed local coals hauled by rail. Little coal moved west to the Pacific rim.

Table 67.—Distribution of Coals (bituminous, subbituminous, and lignite) Produced in the Western United States in Calendar Year 1979 by District of Origin and Method of Movement (tonnage in thousands of tons)

			District of origin						
Geographic division, State of destination	Total shipped to receiving State	Total originating from Western Coal District (and percent of State total)[a]	Percent from Western Interior coal province	Percent from Colorado and New Mexico[c]	Percent from Arizona, California, and New Mexico[d]	Percent from Idaho and Wyoming	Percent from Utah	Percent from North and South Dakota	Percent from Montana, Alaska, Oregon, and Washington
Ohio	72,804	3,835 (5%)							
River		5%				5			
Indiana	52,320	5,000 (9.6%)							
Rail		7.7%		2.3		2.3	0.5		2.4
River		1.9%					1.9[e]		
Illinois	42,719	15,297 (36%)							
Rail		35.7%	Neg	4.1		15.4	0.4		15.7
River		0.1 %	0.1						
Michigan	32,385	4,353 (13.4%)							
Great Lakes		13.4%							13.4
Wisconsin	15,192	5,546 (36.5%)							
Rail		31.5%				17.5			14
River		4.8%							4.8
Truck		0.1	0.1						
Minnesota	14,225	12,786 (90%)							
Rail		77.3%	Neg	Neg		Neg		9.2	68
River		4.6%	0.2						4.4
Great Lakes		7.8%				Neg			7.8
Truck		0.2%	0.1						Neg
Iowa	13,571	9,382 (69%)							
Rail		61 %	3.4	4.5		52	Neg		0.8
River		5.7%				3.8			1.8
Truck		2.3%	2.3						
Missouri	24,356	9,339 (38%)							
Rail		22.9%	9.8	3.7	1.1	8.3	Neg		
Truck		10.5%	10.5						
Tramway, etc.		4.9%	4.9						
North Dakota	11,050	11,049 (1 00%)							
Rail		21.6%				Neg		21.6	
Truck		34.3 %						34.3	
Tramway, etc.		44%						44	
South Dakota	2,912	2,911 (100%)							
Rail		94.7%		0.2		5.8		89	
Truck		5.3%				5.3			
Nebraska	4,929	4,929 (100%)							
Rail		100%	Neg	8.4		86	5.6		Neg
Kansas	9,640	9,634 (99.9%)							
Rail		83%	6.7	3.9		72	0.1		
Truck		17%	17						
Florida	6,193	33 (0.5%)							
River		0.5%	0.5						
Tennessee	28,703	Neg[f]							
Alabama	25,989	Neg[f]							
Mississippi	2,820	957 (34%)							
Rail		33 %	Neg	24			9.5		
River		1%	1						
Arkansas	1,988	1,940 (98%)							
Rail		84%	6.3			78			
River		3.8%	3.8						
Truck		9.6%	9.6						
Oklahoma	4,854	4,834 (99.6%)							
Rail		95%	3	0.2		92			
Truck		4.9%	4.9						
Texas	41,090	40,228 (98%)							
Rail		32.6%	2.3	1.6	Neg	24			4.4
River		0.2	0.2						
Truck		13.8%	13.8						
Tramway, etc.		51.3%	51.3						
Colorado	13,251	13,046 (98.5%)							
Rail		67%		43		23	Neg		
Truck		32%		32			Neg		

Table 67.—Distribution of Coals (bituminous, subbituminous, and lignite) Produced in the Western United States in Calendar Year 1979 by District of Origin and Method of Movement (tonnage in thousands of tons) —Continued

			District of origin						
Geographic division, State of destination	Total shipped to receiving State	Total originating from Western Coal District (and percent of State total)[a]	Percent from Western Interior coal province	Percent from Colorado and New Mexico[c]	Percent from Arizona, California, and New Mexico[d]	Percent from Idaho and Wyoming	Percent from Utah	Percent from North and South Dakota	Percent from Montana, Alaska, Oregon, and Washington
Utah	6,797	6,796 (100%)							
Rail		27.3%		18.3		0.4	8.5		
Truck		45.3%		Neg		0.8	44.5		
Tramway, etc.		27.4%					27.4		
Montana	3,731	3,730 (100%)							
Rail		32%		0.8		3.5	1.2		26.3
Truck		0.3%				0.2			0.1
Tramway, etc.		68%							68
Idaho	516	516 (100%)							
Rail		96%		2.1		81	13		
Truck		3.9%					3.9		
Wyoming	16,005	16,005 (100%)							
Rail		17%				16.5	0.3		
Truck		32%				32	0.3		
Tramway		51%				51			
New Mexico	8,702	8,702 (100%)							
Truck		29%		1	28				
Tramway		71%			71				
Arizona	12,878	12,878 (100%)							
Rail		100%		4	95		1		
Nevada	4,303	4,303 (100%)							
Rail		25%		2		Neg	23		
Truck		75%			75				
Washington	5,664	5,643 (100%)	0.3	0.2		2.3	7.7		
Rail		10.5%							
Tramway, etc.		89.2%							89.2
Oregon	243	242 (100%)							
Rail		100%	2.8	0.8		89.7	6.2		
California	2,735	2,730 (99.8%)							
Rail		99.8%		37.6	11	51			
30-State total	482,565	216,644 (45%)							

a percentage ma, not add due to rounding, Neg indicates negligible coal tonnage.

[b] Thls province includes all of Kansas, Missouri, Texas, and Oklahoma counties of Coal, Craig, Latimer, Muskogee, Okmulgee, Pittsburg, Rogus, Tulsa, and Wagoner.

[c] lncludes all of Colorado, and those counties in New Mexico not listed in fotnote d.

[d] **Includes all of Arizona and California, and the following counties in New Mexico: Grant, Lincoln, McKinley, Rio Arriba, Sandoval, San Juan, San Miguel, Santa** Fe, and Socorro.

[e] River transport accounts for only a portion of the route; coal is shipped by rail to barge terminal.

[f] Delivery is by river

SOURCE: DOE, *Bituminous and Subbituminous Coal and Lignite* Distribution *Calendar Year 1979* (Washington, D. C.: DOE, April 1960). Table 3, pp 27-67.

Table 68.—Western Coal Consumed as Percent of Total Coal Used in the 30 States Consuming Western Coal, 1979

Less than 10%	11 to 25%	26 to 50%	51 to 75%	76 to 100%
Ohio 5%	Michigan. 13%	Illinois. 36%	Iowa 69%	Minnesota 89%
Indiana 1O%		Wisconsin 36%		Arkansas 98%
Alabama . . . . . . O%		Mississippi. 34%		Oklahoma. 100%
Florida 1%		Missouri 38%		Texas 98%
Tennessee. . . . . O%				Colorado. 98%
				Utah 100%
				North Dakota 100%
				South Dakota 100%
				Nebraska 100%
				Kansas 100%
				Montana 100%
				Idaho. 100%
				Wyoming 100%
				New Mexico 100%
				Arizona 100%
				Nevada 100%
				Washington 100%
				Oregon 100%
				California 100%

SOURCE: Calculations derived from DOE data in table 67,

Table 69.—Destination of Western Coal Production in 1979 (millions of tons)

Geographic division	Less than 3 million tons/year	3 million to 5 million tons/year	5 million to 10 million tons/year	10 million to 15 million tons/year	15 million tons plus/year
East North Central		Ohio . . . . . . .3.8 Indiana. .. ..5.0 Michigan .. .4.3	Wisconsin 5.5		Illinois .. .15.2
East South Central	Alabama . . . . . . Neg. a Mississippi. .. .1.0 Tennessee. . . . . Neg.[a] Florida . . . . .0.01[b]				
***West North* Central**	S. Dakota 2.9	Nebraska. .,4.9	Iowa . ...9.4 Missouri 9.3	Minnesota .. .12.8 N. Dakota. .. .11,0 Kansas. 9,6	
West South Central	Arkansas 1.9	Oklahoma ..4.8			Texas. .. .40.2
Mountain	Idaho. ... , ...0.5	Montana .. .3.7 Nevada 4.3	Utah . ...6,8 New Mexico .. .8.7 Washington .. .5.6	Colorado .. ..13.0 Arizona. 12.9	Wyoming .16.0
Pacific	Oregon ., ...0.2 California 2.7				

[a]Negligible tonnage.
b Florida is grouped in this category for convenience

SOURCE: Office of Technology Assessment, derived from DOE, *Bituminous, and Subbituminous Coal and Lignite Distribution Calendar Year 1979* (Washington, D. C,: DOE, April 1960).

Rail: Capacity Assessment

Railroads carry most leased coal because rail is the only transportation mode currently available to move large quantities of coal away from leases. In most cases, a mine is served by a single rail line.[1] Rail transport is also an efficient, available way to move the coal over long distances to major consumers.

Western rail lines are adequate to handle current coal shipments. Car shortages and traffic bottlenecks were a problem in the past, but the National Coal Association has not heard similar reports for more than a year.[2]

Railroads are expected to maintain their dominant position in the transportation of Western coal, The ability of Western railroads to handle increased future production of Federal coal will be influenced by: demand for rail services to transport Federal coal, non-Federal coal, and noncoal commodities; the capacitities, condition, location, and utilization of rolling stock, tracks, and loading and unloading facilities; and the management, investment policies, and financial characteristics of rail carriers, shippers, and utilities.

Physical Capacity

Future Western coal traffic may stretch the physical capacity of the railroads. The National Energy Transportation Study (NETS) predicted a ", . . potential shortfall in the capacity of the Nation's railroad system as it now exists to move the 1990 predicted coal traffic particularly in the West."[3] congestion was projected to occur at almost 50 Western rail links in 1990, and a smaller number of congested links were identified for 1985 at lower coal traffic. The l990 capacity shortfall assumes that Western coal shipments by rail increase from about 97 million tons in 1975 to 625 million tons, and that no new rail investment occurs other than that already underway as of 1979 -1980.4 More recent Department of Energy (DOE) coal production forecasts show smaller increases in Western coal traffic, projecting that the NETS 1985 traffic level will not be reached until nearly l990. This would give the railroads much more time to improve their facilities.

Several problems in the physical plant of the Nation's railroads have been identified which bear on Western rail capacity. Limited locomotive-manufacturing capacity may prove to be one constraint because expected locomotive requirements in 1990 for all rail needs are "substantially in excess of current fleet size," according to the ICC.[5] A doubling of the current national 28,000 locomotive fleet is estimated to be needed by l990, which would require a 15- to 20-percent growth in locomotive-manufacturing capacity annually, While some excess capacity in locomotive manufacturing is currently reported to exist, heavy demand for locomotives may tax the capability of this sector to respond.

The adequacy of the hopper-car fleet may be another question mark. The Association of American Railroads (AAR) estimates that 285,000 cars, 80 percent of the open-top hopper fleet, were dedicated exclusively to coal. The fleet averaged 84.5 tons capacity and 25.5

[1]The National Coal Association (NCA) estimates that 85 to 90 percent of Western coal production is "captive" to a single carrier. The Association of American Railroads (AAR) claims there is no merit in NCA's assertion. "Such an assessment overlooks competition among railroads, among different coal-producing areas—served by competing railroads—and competition with other sources of energy, " according to William H. Dempsey, president of AAR. DOE could not come to any firm conclusions regarding possible anticompetitive effects of railroad involvement in Western coal, although it warned of "possible" problems if coal is leased to the Burlington Northern. Department of Energy, Coal Competition: Prospects for the 1980s, *Draft Report* (Washington, DC.: DOE, January 1981), pp. 270-291.

[2]Telephone interview with Joseph Lema of the National Coal Association, March 1981.

[3] U.S. Departments of Energy and Transportation, National Energy Transportation Study: A Preliminary Report to the President (Washington, D. C.: DOE/DOT, July 1980), p. iii (hereinafter INETS).

[4]Ibid., pp. 34, 37.

[5]International Commerce Committee, Ex Parte No. 347 Western Coal Investigation-Guidelines for Railroad Rate Structure (Washington, D. C.: ICC, 1979).

trips each in 1979.[6] With these figures, AAR calculated the 1979 theoretical capacity of the coal fleet at 616 million tons, 23 percent in excess of the **500** million tons estimated to have been originated on both major and lesser railroads. However, the average coal car made 23 rather than 25 trips in 1979 (with 45 maintenance days), thereby reducing calculated fleet capacity to about 555 million tons, an excess of 11 percent rather than 23 percent. It is difficult to determine whether the average coal car made fewer trips than the fleet average because of lack of demand or operational difficulties.

Unit trains haul most Western coal and almost all Federal coal. These trains typically consist of 100 100-ton hopper cars that shuttle exclusively between a mine and a utility. A growing percentage of these cars—now about 40 percent—are owned by the utilities themselves. The amount of rolling stock needed in the next decade will depend on coal demand and the time needed to complete **a** unit train cycle—loading, hauling, unloading, and return. The shorter the cycle, the fewer cars are needed, other things being equal. Cycle time, which ranges from several days to 14 days or more,[7] is a function of the efficiency of the loading and unloading facilities, rolling stock, roadway, and traffic control systems. unit trains typically experience shorter cycle times than mixed-freight trains—most Burlington Northern (BN) unit trains make their roundtrips in 4 to 7 days[8]—and their utilization is generally much higher.[9] The coal fleet could be stretched by future coal traffic if current overcapacity is-taken as a sign to reduce future car orders. If demand for another bulk commodity, e.g., grain, were suddenly to rise, coal cars owned by the railroads might be quickly converted. This kind of situation encourages utilities to invest the $45,000/car in buying their own hoppers.

Rail capacity did not present a problem in 1980 as the growth in coal demand slowed and improvements were made in rolling stock and roadways. Three years ago, a number of Western coal shippers reported problems in obtaining hopper cars for mine loadings despite excess capacity on paper. Peabody's Big Sky Mine reported, for example, a shortfall of 200,000 tons—about 9 percent of total planned production in 1978—due to car shortages and scheduling difficulties.[10] A similar situation was reported at ARCO's Black Thunder Mine. Coal car shortfalls forced ARCO to ship less coal than required by its contracts. The cycle time from ARCO's mines to Southwest Public Services' Barrington Station plant in Amarillo, Tex., jumped from 87.5 hours (as stipulated in its 1977 BN contract) to 190 hours in 1978, and the utility was forced to increase the number of unit trains and purchase coal from other suppliers.[11]

The recent slower growth in demand for Western coal has reduced the pressure on the Western railroads. This breathing spell has enabled the rail lines and utilities to have new rolling stock delivered before widespread shortages materialized. The diversification of hopper-car ownership should also benefit coal deliveries by creating less pressure on the rail-owned fleet and by guaranteeing car availability to large utility consumers. When a railroad controls the hopper cars, it controls their distribution and can, if it chooses, favor some shippers. Utility ownership of hopper cars then provides an insurance for the utility that its coal can be shipped.

It does not appear that the reported coal car shortages of 3 years ago had much to do

[6] AAR, "Submission to the interagency Coal Export Task Force," Oct. 2, 1980, p. 14.

[7] Data from the Association of American Railroads indicate that the cycle time of the average coal car was about 14 days in 1979. This figure was derived by dividing 365 by 25.5, the average number of trips per year, according to AAR. See AAR, "Submission," p. 16. The Congressional Research Service calculated a 13-day average coal car cycle several years ago, See U.S. Senate, Committee on Energy and Natural Resources, and Committee on Commerce, Science, and Transportation, National Energy Transportation, Vol. I—Current *Systems* and Movements (Washington, D. C,: U.S. Congress, 95th Cong., 1st sess., 1977), p. 56.

[8] 0TA correspondence with Allan Boyce, Assistant Vice-President of Burlington Northern, Feb. 26, 1981.

[9] Willard D. Weiss and Ronald Dunn, "Modern Railroad Concepts for Transporting Western Coal, " a paper presented at Engineering Foundation Conference on Transportation of Fuels for Utility Consumption (Henniker, N. H., 1976), p. 3.

[10] OTA draft report on the Wyoming task force.

[11] Ibid.

with technology, fleet capacity, or railroad finances. Since the railroads have argued that their capacity has always been adequate—indeed, in excess–the shortages that have developed may have been caused by railroad policies regarding maintenance, traffic coordination and the like, and management inefficiencies with respect to planning and investment. It is reasonable to assume that the more Western coal production strains fleet capacity in the future, the greater the role that management policy and management efficiency will play,

Two other major rail infrastructure factors—roadway variables and traffic-control systems—determine the number of trains that can use existing track at any one time. Carrying capacity is related to track configuration, the extent of single and double trackage, the number of sidings, and their length and spacing. Double tracks facilitate fast haulage in both directions, Sidings on a single track allow trains to pass in either direction. The more sidings and the closer their spacing, the more trains can be run on a single track. The longer the siding, the longer the train a track can handle. Traffic control systems determine how close trains can be operated to each other. Automated Block Signals (ABS), a manual system, is less capable than Centralized Traffic Control (CTC), a radio and remote control arrangement, Table **70** estimates the number of coal unit trains that can be run on three different track configurations with a CTC signal system. Longer sidings that are closer together can double the daily train traffic on a single track. Double tracking has three to five times more capacity than a single track.

BN, which originated more than half of the coal hauled by rail in the West, controls three key rail corridors from the Powder River basin:

1. the line east through North Dakota into the North-Central States;
2. the line east through Nebraska and Iowa; and
3. portions of the line south through Colorado and Texas.

Table 70.—Estimated Capacity of Alternative Track Configurations With Centralized Traffic Control (CTC) Signal System

Configuration of rail line	Average number of coal unit trains per day[a]
Single track	
2½ mile sidings, 11 miles apart . . .	20-25
2½ mile sidings, 7 miles apart. . . .	30-35
5 mile sidings, 7 miles apart.	40-45
Alternating single/double track	
10 miles double and 30 miles single track, with 2½ mile sidings	50-55
10 miles double and 10 miles single track	60-70
Double track	70-125

[a] Assurnes a capacity of 10,000 tons per train.

SOURCE: Samir A. Desal and James Anderson, *Rail Transportation Requirements for* Coal Movements *in* 1980 (Cambridge, Mass.. Input Output Computer Services, Inc , 1976), p 2-32.

BN has been upgrading the single track with sidings on its Nebraska line (between Alliance and Lincoln), which had an estimated capacity of 15 to **20** trains per day in the mid-1970's,[12] A CTC signal system with double track and alternating single and double tracks are being installed. The Union Pacific (UP) appears to be better able to transport Wyoming coal east because it double-tracks and uses heavier gage rail.[13] However, the east-west UP line through southern Wyoming and Nebraska does not originate coal from the Powder River basin, which is served exclusively by BN. UP track in Wyoming and Nebraska is divided about equally between CTC and ABS traffic control systems.

Financial Considerations

NETS estimated that all railroads will have to invest **$5** billion to **$7** billion between 1978 and 1985 in rolling stock to have the capacity to handle all future traffic.[14] Another $4 billion to $5 billion will be needed to upgrade existing track and construct new coal-trans-

[12] Montana Energy Advisory Council, Montana's Major Energy Transportation Systems: Current Conditions and Future Developments (Helena, Mont.: State of Montana, December 1976), p. 49.

[13] Comment from the Wyoming task force, Wyoming Report, vol. 1, p. 63.

[14] NETS, p. 62.

port lines.[15] Inasmuch as most additional coal production will occur in the West, it can be assumed that at least half of these sums will need to be invested there by Western railroads. Recent coal traffic projections indicate that this schedule may be stretched out, but the investment will ultimately be necessary.

Western railroads range from highly profitable to below-average money makers.[16] Table 71 presents company performance data for 11 railroads, assembled by Forbes, The two largest Western coal carriers—Burlington Northern and Union Pacific—both ranked near the top of the list in growth, but were very different in profitability. BN, the major Western coal line, showed below-average profitability measures, but UP profitability was well above average for the railroad industry.

‘[5]1 bid., p. 64.

[16]The Milwaukee line is bankrupt. A revised reorganization plan will be presented to a Federal District Court on Sept. 15, 1981. Shippers, States, and other railroads are negotiating the purchase of Milwaukee track. BN and UP have acquired about 500 miles so far. Standard and Poor rated Western roads in 1979 as follows: Union Pacific (AAA), Santa Fe (AA), Denver& Rio Grande (A), Southern Pacific (A), Burlington Northern (A), Missouri Pacific (A-), Chicago & Northwestern (B), and Milwaukee (D). A number of mergers are being negotiated that may affect coal haulage, including the Union Pacific with the Missouri Pacific, Burlington Northern with the St. Louis-San Francisco, and the Santa Fe and Southern Pacific.

A railroad’s ability to borrow capital or raise it through stock sales is closely related to its rate of return over a period of time, as well as expectations of future growth. Many Western railroads are subsidiaries of diversified companies who must choose where their capital should be invested. In 1977, return on rail assets amounted to 8.6 percent for the Denver and Rio Grande; 3.3 percent, Burlington Northern; 5.9 percent, Santa Fe; **2.3** percent, Southern Pacific; **7.9** percent, Union Pacific; **5.8** percent, Missouri Pacific.[17] Yet the parent companies of these lines made at least 10 percent on their other assets (nonrail transport, real estate, forest, and natural resources). Table 71 shows a similar comparison between the rail industry and the all-industry medians.

Table 72, which summarizes the coal business of the major Western railroads, indicates that the coal revenues received by the Western roads were low in proportion to coal’s share of their total freight traffic. Coal, for example, made up 44 percent of BN’s total freight in 1978, but accounted for only 24 percent of all of BN’s freight revenues,

[17]NET's, p. 67.

Table 71 .—Railroads: Yardsticks of Management Performance

	Profitability								Growth			
	Return on equity				Return on total capital				Sales		Earnings per share	
Company	5-year average	5-year rank	Latest 12 months	Debt/ equity ratio	Latest 12 months	5-year rank	5-year average	Net profit margin	5-year average	5-year rank	5-year average	5-year rank
Chicago & North Western	27.1%	1	45.9%	2.2	10.2 %	6	6.6%	4.0%	10.8%[a]	6	20.8%	[a] 3
Missouri Pacific	26.7	2	21.8	1.1	10.9	1	11.2	8.0	14.2[a]	4	18.7[a]	5
Union Pacific	13.3	3	15.6	0.3	10.3	2	8.9	8.6	19.5	1	21.0	2
Southern Railway	12.9	4	14.3	0.6	8.1	4	7.4	10.6	10.6	7	13.3	9
Norfolk & Western Ry	12.6	5	15.1	0.3	9.5	3	7.4	13.6	5.9	11	18.9	4
Santa Fe Industries	10.4	6	13.3	0.3	8.9	5	7.2	9.0	13.4	5	14.3	7
IC Industries	9.8	7	10.2	0.7	5.7	7	6.1	2.7	19.4	2	13.3	8
St Louis-San Fran Ry	8.0	8	10.3	0.8	6.3	9	5.1	5.3	9.4	8	14.5	6
Burlington Northern	7.2	9	10.7	0.5	7.0	8	5.2	5.5	14.9	3	25.5	1
Southern Pacific	6.9	10	7.1	0.6	4.8	10	4.9	5.3	8.7	10	6.4	10
CSX	(b)		(b)	(b)	(b)		(b)	6.7	9.2[a]	9	6 1[a]	11
Industry medians	11.5		13.8	0.6	8.5		6.9	6.7	10.8		14.5	
All industry medians	15.8		16.1	0.4	11.0		11.1	5.0	14.3		13.9	

[a]Four year growth.
[b]Not available: not ranked.

SOURCE: *Forbes,* Jan. 5, 19b1, p. 92

Table 72.—Coal Carried and Revenue Received as Percentage of Total Freight for Western Railroads, 1978

Railroad	Coal originated: Tonnage (million tons)	Coal originated: Coal as percent of all freight	Total coal revenues: Coal revenues (million dollars)	Total coal revenues: Coal revenue as percent of all freight revenue
Burlington Northern	63.0	44	$463.7	24
Union Pacific. ... , ...	17.3	26	167.6	11
Denver & Rio Grande	13.2	69	65.7	31
Missouri Pacific	9.2	14	63.8	5
Milwaukee	4.9	19	34.0	8
Chicago & Northwestern .	2.6	6	44.2	8

SOURCE. National Coal Association, *Coal Traffic Annual, 1979 Edition* (Washington, D C. NCA, 1980), p II-8

On the other hand, the unit costs of moving coal are lower than costs for many other commodities. Western coal haulage costs are lowered by the extensive use of dedicated, highly cost-effective unit trains, often owned by the consumer rather than the carrier. Coal shippers, unlike consumers of many other rail-hauled commodities, even build and operate their own loading and unloading facilities. Railroads also use a betterment accounting system, which tends to show lower earnings than would depreciation accounting. These factors mitigate what otherwise seems to be a generally bleak profit picture for coal haulage by Western carriers.

Rail-related capital can be raised in many ways. However, the parent companies of Western railroads may be reluctant to invest their limited capital in new rail capacity if nonrail investments consistently generate greater returns. Consequently, future rail investment and capacity for Federal coal seems to be linked more to the investment priorities of individual railroads than to questions of physical plant, technology, and capital availability. Although sufficient investment has been undertaken to provide adequate capacity for current and future coal traffic over the next few years, constraint on Western coal production could develop by 1990 or 1995 if the railroads decide not to make additional capital stock investment and roadway improvements.

This question of capital application was spelled out in detail by Richard Bressler, President and Chief Executive Officer of BN to Western utility executives, Bressler said:

> One of the first things 1 did at Burlington Northern was to look at where our investments had been made.
>
> Here's what I found. For many years, Burlington Northern has invested more than its cash flow,
>
> . . . and a large part of those investments has gone to coal–into our ability to haul coal from the Powder River basin to you, the utilities. . . .
>
> about $1 billion has been intvested in (coal-carrying) capability so far. Our plans call for the investment of another billion over the next several years.
>
> . . . Last year, the railroad made $41 million before tax, according to our annual report.
>
> $41 million–that's a before-tax rate of return of less than 4 percent on what Burlington Northern recently invested in coal-hauling alone. Less than 4 percent.
>
> I can look at an array of tariffs and figure out that relatively little of that $41 million came from hauling coal,
>
> . . . we at Burlington Northern will be very careful about future investments in coal-hauling capacity—at least until the picture is clear.
>
> Burlington Northern has other good investment opportunities, many solid opportunities.
>
> . . . Burlington Northern is prepared to continue investing in coal capacity. We are prepared to continue our commitment, assuming there is a reasonable return on such investments, (Emphasis in the original.)18

[18] Richard M. Bressler, "Remarks Before the Western Coal Transportation Association" Denier, Sept. 10, 1980.

The unclear picture of the future to which BN's Bressler referred involves future rail rates, coal demand, litigation (utilities have 18 separate suits against BN related to coal-hauling contracts), and slurry pipelines. If an appreciable investment is made in pipelines, BN vice-president Allan Boyce said, the railroad will cut back its coal-related investment.[19]

If return is not sufficient to cover anticipated investment, other financing arrangements—such as borrowing, shipper or customer purchase of hopper cars, shipper construction of roadway, or public subsidy, among others—will be considered. Such arrangements are an increasingly common way of financing new railroad equipment. Rolling stock is normally financed through either leases (often from banks) or equipment trust certificates, which are, in effect, mortgages. Utilities that have long-term coal contracts now frequently finance the hopper cars and locomotives necessary to transport the coal. In some cases, utilities and coal shippers are also providing money to the railroads for improving roadbeds. The Staggers Act of 1980, which partially deregulated the railroads, provides the legal framework for utilities to negotiate long-term contracts with railroads. Coal industry spokesmen believe that customers and shippers will begin to negotiate such contracts because they introduce more predictability into rate and supply issues.

Western railroads have made major capital investments in recent years to meet expected coal traffic. The higher efficiencies that this investment has produced and the slower-than-expected rate of growth for Western coal has resulted in excess coal-haulage capacity throughout the Western rail network. The railroads have argued that the Interstate Commerce Commission's (ICC) rates have not produced sufficient return to continue investment at recent levels. Excess capacity is an inefficient use of capital and tends to inflate rail rates. However, if rail rates are not high enough, additional needed investment will not be made. Rates must cover necessary investment but not excessive overcapacity. Even though excess capacity is now a common complaint among railroad operators, they have argued that ICC rates have not been adequate to meet their needs. For example, Thomas J. Lamphier, president of BN's transportation division, recently wrote:

> Unit train coal traffic requires a heavy-duty rail system in order to withstand the continuous impacts of this heavy tonnage on the rail and roadbed. It also requires long sidings and automated signaling to allow for fast movement of coal trains together with non-coal trains, These requirements involve enormous amounts of capital to be generated from internal earnings and from external sources. Unfortunately, recent ICC and court decisions have produced an uncertain pricing atmosphere to the point where it is doubtful that the revenues permit the recovery of full costs involved in the traffic, much less recovery of the large increases in costs as they arise in today's inflationary environment. (Emphasis added.)[20]

Coal-haul rates vary according to distance, tonnage, and other factors. A representative example is the $20.42/ton cost—$0.0127/ton mile—of hauling Powder River basin coal from Gillette to Smithers Lake, Tex., a distance of 1,607 miles.[21] (Eastern hauls are shorter than Western hauls—generally between 150 and 400 miles—and costlier: the rate for the 346-mile trip from Bluefield, W. Va., to Norfolk, Va., is $12.59/ton, or $0.0356/ton mile.) ICC has approved rate increases for Western coal traffic in recent years, 20 to 30 percent boosts being common since the late 1970's.

On the other hand, utilities say that the current transportation charges, which can amount to over 70 percent of the delivered cost of a ton of Western coal, * are not justi-

[19] 0TA telephone interview with AlIan Boyce, Assistant Vice-President of Burlington Northern, March 1981,

[20] Correspondence between Thomas J. Lamphier and Arthur Ingberman of DOE, Aug. 26, 1980, included in AAR's "Submission," p. 23.

[21] Rates included in letter from John S. Reed, Chairman and Chief Executive Officer of the Atchison, Topeka. & Santa Fe Railway Co. to William Dempsey, President and Chief Executive Officer of the Association of American Railroads, Aug. 19, 1980, included in the AAR's "Submission, " p. 20.

*See, for example, table 28 in ch. 5 of this report.

fied by carrier costs. They argue, further, that ever higher rail charges and unreliable service are forcing them to develop other sources of supply and other modes of transportation. Assuming rail transportation costs continue to rise, Western coal customers can be expected to consider shifting part of their purchases to closer suppliers. This constitutes an economic rationalization that may reduce the growth of Federal coal production, or, at least, geographically reapportion Federal production. The ICC's Ex Parte 347 decision on Western rail rates in November 1980 could result in an annual increase in Western coal rates of from 2 to 10 percent annually.[22] The Staggers Rail Act of 1980, which deregulated part of the rail industry, will have little direct effect on Western coal haulage since ICC retains regulatory authority over “market dominant” commodities, of which ICC considers Western coal to be a “classic” example,

[22]Telephone conversation with John Sado, ICC lawyer who was involved in Ex Parte 347, January 1981. Sado emphasized that the 2 to 10 percent figure was a reasonable speculation. Ex. Parte 347 describes the railroads as a “relatively anemic” industry . . . [whose] shortage of internally generated funds has led to the deferment of road maintenance and the delay of road capital . . and an increased reliance on debt and lease obligations. ” (Ex. Parte 347, pp. 4-23).

Rail: Constraint Analysis

The major potential constraints on increasing Western coal traffic, other than physical and financial capacity, can be grouped into two categories: socioeconomic problems and environmental-safety problems.

In the past, railroads brought economic life to the communities through which they passed. Today, increasing coal traffic can create serious disruptions in Western communities that are bisected by rail lines carrying heavy traffic. If the line has been a heavy carrier for many years, communities are likely to have adapted or made the necessary investments to resolve delays. Where the increase in traffic occurs suddenly, severe disruption and a lack of resources may combine to create public concern. The ICC noted that:

> increased unit train operations on these [existing Western] routes may reach a level which may disrupt transportation, land use, and social patterns of the residents. . . . It should be noted, however, that unit trains will not create any new or unique impacts, . . . Rather, the same railroad/community problems that have existed in the past may be intensified and what might have historically been regarded as a slight annoyance could potentially develop into a significant community problem.[23]

[23]Ex Parte 347, p. 5-86.

Delay caused by train operation is the major rail-related impact whose disruptiveness could give rise to community opposition and become a constraint on Federal coal development, Heavy unit-train traffic during which dozens of 100-car trains pass through a town for a number of hours each day can interfere with normal business, commuting, emergency vehicles, and school schedules. Several hundred crossings are likely to be affected by increased Western coal traffic and a somewhat smaller number of grade separations are likely to be needed.

Grade separations and improved signaling systems are often prohibitively expensive for local governments to finance. Western States are now surveying their specific needs, NETS discussed alternative sources of financing new highway grade crossings, among which are railroad financing, State funding, and Federal funding (Highway Trust Fund, general revenues, national coal severance tax, and a carrier tax.)[24] NETS did not make a recommendation on this matter but concluded:

> Blocking of grade crossings may become a significant problem both to communities and to the movement of coal. , . . In the absence of solutions, communities may take actions which could affect coal traffic, Local or-

[24]NETS, pp. 70-71.

dinances prohibiting blocking of crossings more than a given amount of time per hour, coupled with speed limits, could adversely affect the efficiency of coal traffic. Legislation before Congress to limit the length of unit trains would actually increase congestion at grade crossings.[25]

Environmental health and safety is a second potential constraint on rail transport. Fatalities and injuries associated with rail haulage are significant, although OTA estimated that a go-percent increase in train traffic would yield a 21-percent increase in death and injuries.[26] Exposure to train noise is a hazard whose seriousness depends on factors such as the location of the rail lines, population density and topographical and architectural configurations. At 50 unit trains per day, OTA estimates, for example, that 165,000 persons from Gillette to Dallas would be exposed to noise levels exceeding the Environmental Protection Agency (EPA) community noise guidelines.[27] Air quality is likely to be reduced somewhat from locomotive emissions of carbon monoxide, hydrocarbons, nitrogen oxides, particulate, and other pollutants associated with diesel-electric engines.[28] Each of these problems could become a constraint on Federal coal were they to reach serious proportions in a number of places at about the same time,

Increased use of Western coal by Pacific Coast States, or the marketing of Western coal abroad, will enlarge the area affected by rail transportation impacts, Socioeconomic, environmental, and safety considerations could pose particular problems for west coast communities which already experience congestion and air pollution problems.

[25] Ibid., p. 69,

[26] Office of Technology Assessment, U.S. Congress, A Technology Assessment of Coal Slurry Pipelines (Washington, D. C.: U.S. Government Printing Office, March 1981), p. 106.

[27] Ibid., p. 109.

[28] Ibid, p. 114, and Ex Parte .347, p. 5-110.

Coal by Wire: Capacity and Constraints

Most Western coal is sold to utilities who convert it to electricity. As indicated by the earlier discussion of table 67, 40 percent of the Western coal sold to utilities in 1979 was delivered to mine-mouth or nearby generating plants by conveyor, truck, etc., while 60 percent was shipped long distances, principally by rail. Because more than 60 percent of the electric demand supplied by Western coal in 1979 was located at long distances from the mines, a large part of the locally generated electricity was shipped by wire to serve that demand. Since the cost and efficiency of generating plants is the same regardless of whether it is coal or coal-fired electricity that is being shipped in bulk, a utility's decision between the two often revolves on transportation factors, such as cost and reliability, and environmental impacts that may prevent siting of new generating plants and transmission lines in certain areas.

Electricity moves from generating plants via high-voltage wires. Bulk power is supplied through lines in excess of 230 kilovolts (kV). * The bulk power is distributed to regional power pools, which are utility-established organizations that regulate the generation and distribution of electricity among pool members to achieve economic efficiencies.[29] Once electricity is fed into the grid, the point of origin and final destination of any particular unit cannot be identified.[30]

* Utilities also transmit and distribute power. Transmission lines are between 70 and 230 kV, and distribution lines are 69 kV and less.

[29] U. S. Senate, Committees on Energy and Natural Resources; and Commerce, Science, and Transportation National Energy Transportation, 95th Cong., 1st sess., publication No. 95-15 (1977), pp. 353-354.

[30] The Federal Energy Regulatory Commission (FERC) collects data on interstate shipments of bulk power from utilities on FERC Form 412, but does not tabulate this information. The U.S. Senate report cited above did organize these data for CY 1974 (Ibid., p. 372).

High-voltage transmission involves losses in transformers, reactors, and lines that normally consume about 6 percent of the power generated at the mine-mouth.[31] Transmission losses increase with distance, and can be reduced by raising the voltage. Present voltages permit efficient power transmission over distances of several hundred miles. Longer distances can be achieved by using higher voltages or by "wheeling," in which a region imports power to supply a portion of its own demand and passes on its own generated surplus.

Different studies have come to different conclusions regarding the relative cost efficiencies of rail v. wire transportation. A 1975 study by the Bureau of Mines compared the two using Powder River basin coal and consumer destination at 1,000 miles southeast from the mine. This study concluded that unit-train haulage would be about 30 percent less costly.[32] DOE's National Power Grid Study found that a mine-mouth generation plan ". . . may offer a 15-percent cost advantage over the local generation plan."[33] High-voltage transmission has a more stable cost structure than rail haulage, which may constitute its principal economic advantage in the 1980's. Its labor and operating costs are minimal.

Burning coal at mine-mouth plants and shipping by wire is an attractive option for many utilities that own both the generating plant and distribution system, and, thereby, are not dependent on independent carriers. It also attracts utilities because of the relative ease of passing along the costs of capital investment compared with the difficulty of negotiating fuel-adjustment increases. Advantages of this sort might also be viewed as potential anticompetitive, cost-increasing developments for electricity consumers.[34]

Large future increases in the amount of Federal coal shipped by wire may be constrained by several factors. The generating plants require large amounts of water, which is used to cool the electricity-generating apparatus.[35] An alternative is air-cooling. Scarcity of water in the powder River basin justified the expense of constructing the first dry-cooling tower in the United States at the Wyodak Power Plant east of Gillette, Wyo.

Water use by plants may limit other economic activity, particularly water-intensive farming. If mine-mouth plants are planned for cluster areas together with synthetic fuel plants, air-quality standards could be exceeded, Constructing mine-mouth plants in the West also presents local communities with problems because of intense but short-term population growth associated with the construction work force. These problems have given rise to local opposition in some cases to expansion of mine-mouth generating facilities,[36]

The transmission lines have also become objects of controversy. Farmers and other landowners have objected to losing right-of-way land (15 to 20 acres are required per mile of transmission line). A direct-current line from a North Dakota lignite mine to Minnesota's Twin Cities was protested by farmers trying to keep the line off their property.[37] Farm opposition is understandable since radial-spray irrigation systems cannot be used in fields under transmission lines.[38] underground burial of these lines can double

31 DOE, *The National Power Grid Study, Vol. II, Technical Study Reports* [Washington, D.C.: DOE, September 1979), p. 135.

32 U.S. Bureau of Mines, Division of Interfuels Studies, *Comparison of Economics of Several Systems for Providing Coal-Based Energy to Users 1,000 Miles Southeasterly From Eastern Wyoming Coal Fields—Four Modes of Energy Transportation and Electricity Versus Gas and the End Use Energy Forms* (Washington, 1).(; ,: U.S. Government Printing Office, April 1975).

33 DOE, *National Power Grid Study, Vol. II*, p. 149.

34 DOE, *Coal* competition, supra note 1.

35 *NETS* pp. 80-81. Water-cooled steam-generating plants require 7 to 8 tons of water per ton of coal, compared with 1 ton of water for slurry pipelines and negligible amounts for rail haulage.

36 Michael Parfit, *Last Stand at Rosebud Creek: "(~OO l, Power, and People"* [New York: E. P. Dutton, 1980).

37 Barry M. Casper and Paul D. Wellstone, *Powerline: The First Battle of America's Energy War* (Amherst, Mass.: University of Massachusetts Press, 1981).

38 Michael J. Murphy, Susanne Maeder, and James I. McIntire, *Northern Great Plains* Cool: Conflicts *and Options in Decision Making* (Minneapolis, Minn.: Upper Midwest Council, 1976), pp. 6-22.

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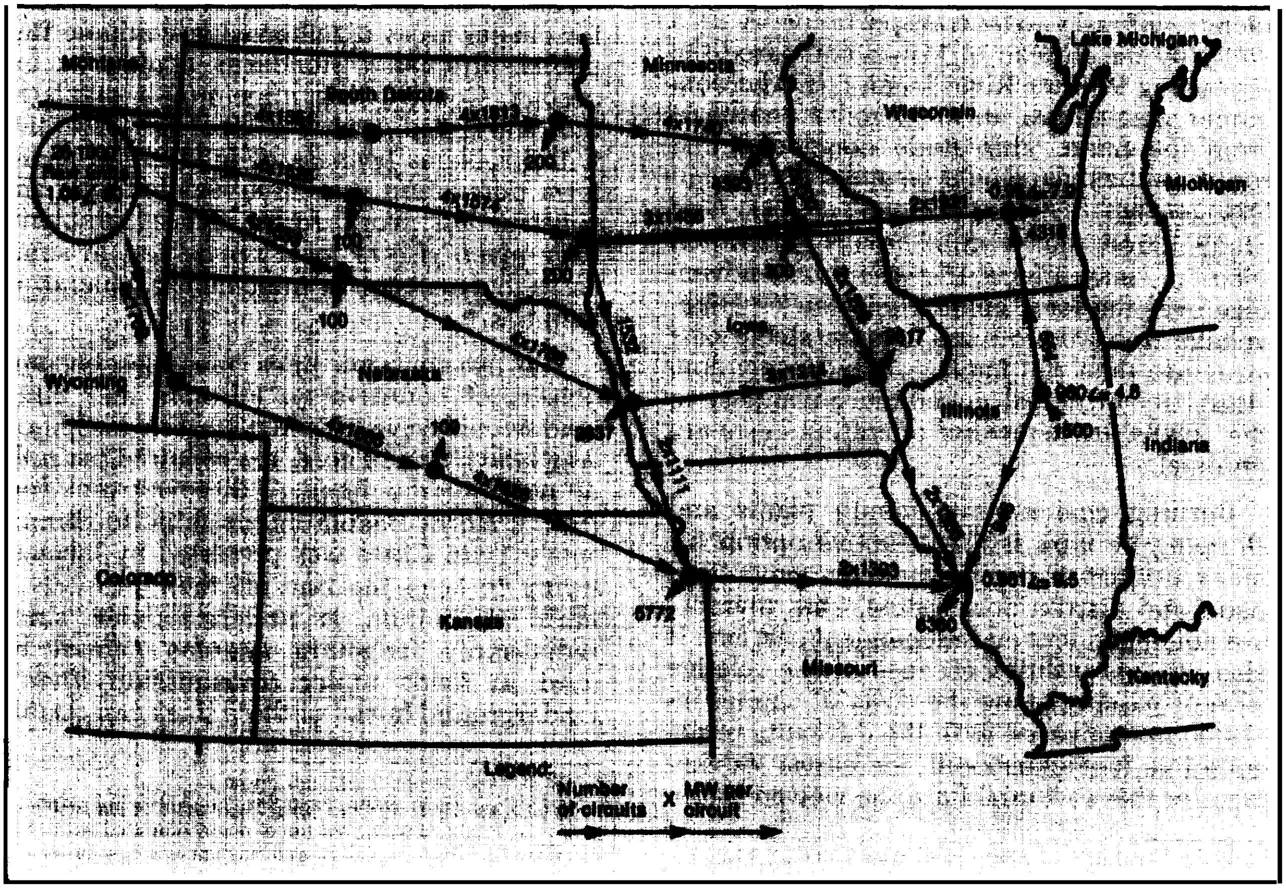
to sextuple the costs.[39] Citizens have also questioned the environmental safety of the electric and magnetic fields surrounding high-voltage lines. Problems associated with corona, noise, spark discharge and ozone have been identified. The long-term biological and health implications of high-voltage transmission lines are not known at this time. However, citizen opposition has made it increasingly difficult for utilities to obtain Western rights-of-way. Construction of a 765-kV system as suggested in figure 38 to handle mine-mouth power could give rise to substantial opposition.

For all these reasons, some industry representatives and environmentalists have urged that it is preferable to site combustion facilities near to the markets for their electricity.

[39] Montana Department of Natural Resources and conservation, Draft Environmental Impact Statement on Colstrip Generating Units 3 and 4, 500 Kilovolt Transmission Lines, and Associated Facilities, Vol. 4, "Transmission Lines" (Helena, Mont.: State of Montana, 1974), p. 37.

Figure 38.—1997 System 765-kV Power Flow



SOURCE: National *Power Grid Study,* p. 133

Truck Haulage: Capacity and Constraints

Trucks hauled almost 33 million tons of Western coal in 1979, 30 million of which utilities consumed. This represented about 15 percent of all Western coal production as well as 15 percent of utility-consumed Western coal,

Coal is trucked to consumers both on and off the public highways. Highway vehicles carry 15 to 30 tons (occasionally more) while off-road trucks can handle up to 150 tons. Trucks are more flexible than other coal-transportation modes. They are a cost-efficient mode for short distances and small quantities of coal, the economical distance varying according to local conditions. One company looking at transportation systems for 5 million tons per year of Texas lignite concluded that truck haulage was limited to a maximum of 10 miles and that truck-rail haulage was cost effective for longer distances.[40] Truck haulage is a simple and familiar technology whose application is generally determined by economic factors, weight limitations on local roads, proximity of mine to consumer, and the like. The physical capacity of truckers to move Federal coal does not appear to represent any constraint on future production.

Truck haulage of coal presents a range of environmental, safety, and socioeconomic problems, particularly where trucks regularly pass through population centers. Noise, dust, and pollution are common causes of citizen complaint. Highway damage is frequently extensive from large coal trucks. More than other coal-transport technologies, trucks are local—the technology itself is familiar and simple; the drivers are local residents who often own or lease the trucks; the impacts are readily seen and understood; and effect is easily related to cause, For such reasons, citizen opposition to extensive truck haulage in a given community may emerge more quickly than opposition to other transportation modes. Even if citizen complaints were numerous, a constraint on Federal production is unlikely to result because most new Federal coal will move by rail or wire.

[40]0TA correspondence with 13. C. Bradley, President of Chaco Energy Co., February 1981.

Waterway-Barge: Capacity and Constraints

Almost 8 million tons of Western coal traveled by river in 1979 and another 5% million tons were shipped on the Great Lakes, Almost all of this tonnage was shipped to electric utilities, and all of it originated by rail, Over half of this coal went to two States, Ohio and Michigan.

The inland waterway system has been constructed and maintained by public authority, the Federal Government, with one exception, Locks are operated by the U.S. Army Corps of Engineers. Lock size is the principal determinant of the extent of river and lake traffic, The main access points for Western coal are: Superior, Wis., on Lake Superior; Sioux City, Iowa, on the Missouri River; and in the St, Louis area on the Mississippi. The Sioux City connection is closest to the Western coalfields.

Barge haulage is a very inexpensive way of moving bulk commodities. Barge service cost averages 6,86 mills/ton-mile compared with 26 mills for rail.[41] The Reagan administration has proposed to increase the fuel tax for bargelines to 30 cents/gal in 1983, which the administration estimates would add less than 4 mills/ton-mile to the operating cost of the

[41]Telephone conversation with Neil Schuster, Vice-president of the American Waterways Operators, Inc., January 1981. Schuster stressed that these cost estimates were for average revenue for all commodities, and that the costs for coal would be less for both barge and rail, Cost data were for 1979.

barge companies. This would represent a 58-percent increase in average barge service cost, "Four mills per ton-mile is a phenomenal jump, an awfully significant increase, when you're talking six to eight mills to move coal," Anthony Kucera, director of the American Waterway Operators Association, said. "The impact would be incredible."[42] A management consultant recalculated the Reagan proposal for an industry newsletter and found that the fuel tax increase would increase expenses by 5 to 8 mills.[43]

Problems have been noted with the capacity of several locks on the Mississippi-Ohio River systems, which exceed or are close to exceeding design capacity.[44] NETS found future congestion to be likely at Dam 26 at Alton, Ill., and the Gallipolis Lock on the Ohio River unless new facilities are built.[45] The extent of any future constraint depends less on the extent of Western coal movement by barge and more on how much additional barge service is required of other commodities, notably oil products.

[42] Northern Coal, Mar. 11, 1981.

[43] Ibid.

[44] The ICC states that "a waterway reaches capacity when the average delay time at a lock exceeds 150 minutes, " ICC, Ex. Parte 347, p. 4-27 referencing U.S. Department of the Interior, 1979, Federal Coal Management Program, Final Environmental Statement, Vols. I and 2 (Washington, D. C.: Bureau of Land Management, 1979). The problem locks include: Locks 50-53 on the Ohio River; Gallipolis Lock on the Ohio; Locks 26 and 27 on the Upper Mississippi; all locks on the Illinois River; Lock No. 3 on the Monongahela River; and the Winfield Lock on the Kanawha River. The ICC says these locks require "long-term structural solutions through the modification or replacement of existing locks" (p. 4-27).

[45] NETS, p. 74.

Coal Slurry Pipelines: Capacity and Constraints

Coal slurry pipelines have not played a significant role in coal transportation. Only one pipeline is currently operating: the Black Mesa line between Kayenta, Ariz., and southern Nevada that has a 4.8-million-tons-per-year capacity and covers 273 miles. This pipeline handled about 0.6 percent of the coal mined in the United States in 1980.

A number of slurry pipelines have been planned or proposed (fig, 39). Nearest to construction is the Energy Transportation Systems Inc. (ETSI) line that would ship Powder River basin coal to Oklahoma, Louisiana, and Arkansas. It would have a capacity of 25 million tons per year. A recent DOE contractor's report forecast that 70 million to 126 million tons of coal could be pipelined in 1990, which would amount to between 5 and 9 percent of all coal transported.[46] This report concluded that several pipelines were most viable, including Arizona to Nevada; Wyoming to Illinois; Wyoming to Texas; Wyoming to Arkansas, Oklahoma, and Louisiana. OTA's investigation reported that coal slurry pipelines ". . . do represent under some specific circumstances the least costly available means for transporting coal measured in economic terms."[47] On the other hand, the construction of a number of Western pipelines would directly affect the investment and capacity decisions of competing railroads. Coal slurry pipelines involve much more complex engineering than gas or oil pipelines and they are not without environmental and social costs of their own.[48] This report also concluded:

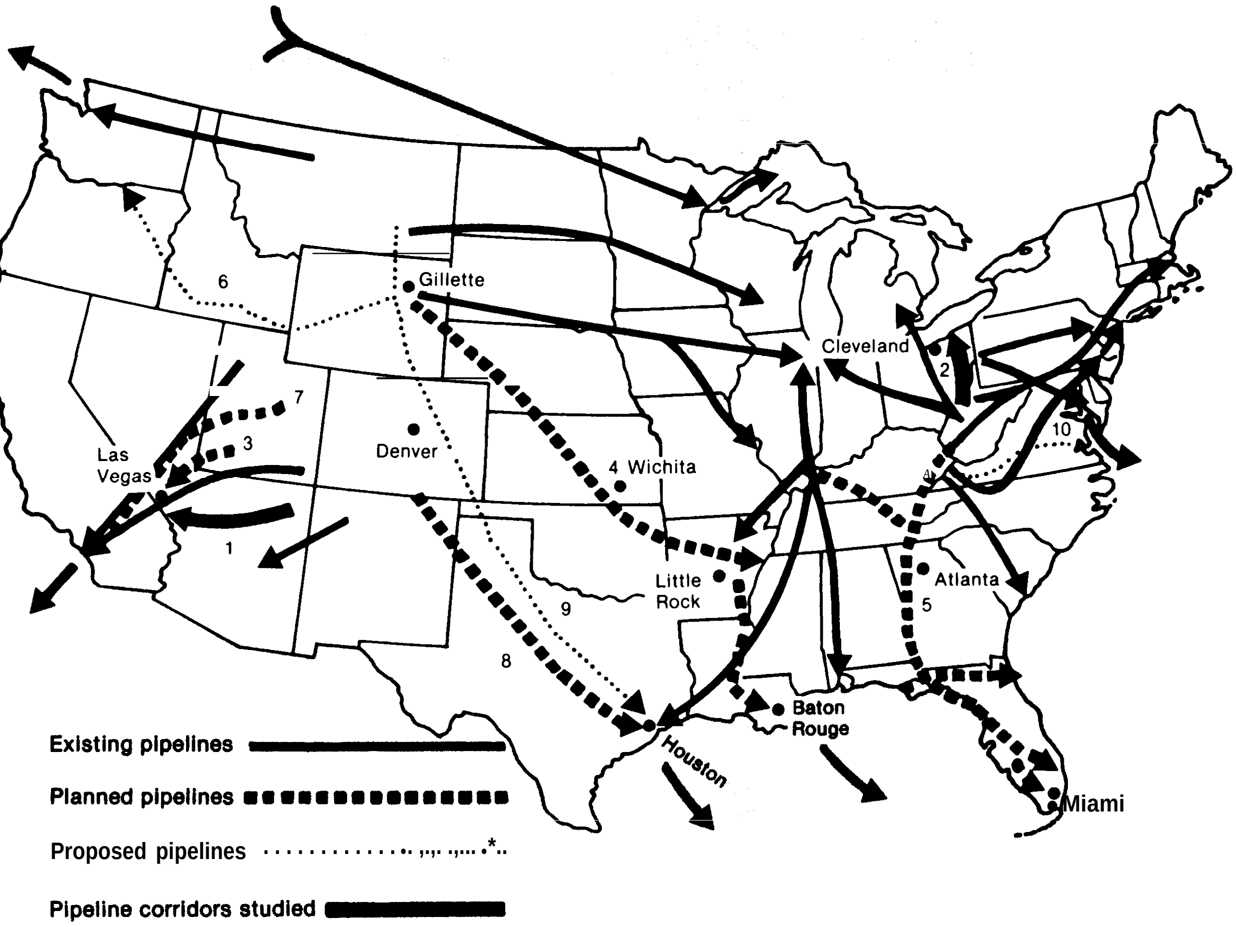
> ,.. the introduction of coal slurry pipelines is not likely to affect materially the rate of coal resource development and use on a national scale. It may, however, affect the regional pattern of coal mining and distribution in such a way as to expand the use of

[46] ICF, The Potential Energy and Economic Impacts of Coal Slurry Pipelines, Draft Final Report (Washington, D. C.: ICF, December 1979), pp. 1-2.

[47] OTA, Coal Slurry pipelines, Summary (Washington, D. C.: U.S. Government Printing Office, September 1980), p. 8. This summary updates an earlier report, A Technology Assessment of Coal Slurry Pipelines (Washington, D. C.: U.S. Government Printing Office, March 1978). The array of legal, economic and environment issues involved in the slurry pipeline debate are discussed in full in OTA's 1978 Assessment and in the 1980 update.

[48] An extensive discussion of these tradeoffs is found in OTA's assessment, Coal Slurry Pipelines, chs. V and VI.

Figure 39.—Coal Slurry Pipeline Systems



Pipeline[a]	Principal company affiliation	Origin	Destination	Distance (miles)	Capacity (million tons/year)	Capacity potential to export (million tons/year)
A. Existing						
1. Black Mesa pipeline (to present)	Consolidation Coal Co.	Kayenta, Arizona	Southern Nevada	273	4.8	None
2. Ohio pipeline (1957-1963)		Cadiz, Ohio	Cleveland, Ohio	108	1.3	None
B. Planned or proposed						
3. Allen-Warner Valley Energy System (Alton pipeline) (1983-19843)	Nevada Power Co.	Utah/Arizona	Nevada	183-256	11.8	None
4. Energy Transportation Systems Incorporated (ETSI pipeline) (1983)		Powder River basin/Wyoming	Oklahoma/Louisiana Arkansas	1,378	25	**0.5**
5. Continental Resources (Florida pipeline) (1985-1986)	Florida Power Co.	Southern Illinois/West Virginia/Kentucky	Georgia/Florida	600 – 1,500	**40-50**	10
6. Northwest Integrated Coal Energy System (Gulf Interstate Snake River pipeline)		Powder River basin Wyoming	Oregon	1,100	25	0.5
7. Pacific Bulk Commodity Transportation System pipeline	Boeing Corp.	Emery, Utah	Oxnard, Cal if.	645	10	10
8. San Marco pipeline (1983)		Colorado/ New Mexico	Houston, Tex.	900-1,100	15	None
9. Texas Eastern (Wytex pipeline) (1985)		Gillette, Wyo.	Houston, Tex.	1,260	25	0.5
10. Vepco pipeline	Virginia Electric Power Co.	Southwest Virginia	Tidewater, Va.	300	5-1o	None
Total[b]					161-176	20-35

[a] Target **operating** date, when available, In parenthesis.

[b] Excluded the closed Ohio Pipeline

SOURCE: Data furnished by Coal Slurry Transport Association, May 1980, and National Coal Association, 1978 western coal to greater distances from its area of origin.[49]

The degree to to which pipelines affect rail traffic depends on whether pipeline operators win passage of eminent-domain legislation and on the level of rail rates. As rail rates increase, the economic attractiveness of pipelines increases as well. If Federal pipeline legislation is enacted, pipeline operators will enjoy a regulatory advantage over railroads. The pipeline industry argues that the absence of Federal eminent-domain legislation is a significant constraint on pipeline construction. Such legislation would make construction easier and accelerate the construction of pipelines, but it does not appear to be essential to the construction of any individual pipeline.

The principal environmental constraint on pipeline construction has to do with water. For any particular pipeline, water availability may not be a problem. However, when water demand for all possible new energy facilities in a western basin, including mine-mouth plants, synthetic-fuel facilities, and pipelines are totaled, water availability can become an important constraint on pipeline construction. Moreover, Montana and Colorado prohibit export of local water, and Wyoming requires legislative approval before export can occur. Assuming that the legal and environmental water issues are resolved, the only likely constraint on pipeline development arising from the operation of the lines would be citizen objection to spillage from breaks. Federal and State environmental regulations may be violated in such accidents.

[49])TA, Coal Slurry pipelines, Summary, p. 9, September 1980.

Port Facilities: Capacity and Constraints

Very little Western coal is being exported to Asia. If Asian exports are to increase, improved port facilities are required. Domestic port facilities at Los Angeles, Long Beach, and Stockton, Calif., are currently capable of loading only several million tons per year. plans for expansion of these port facilities have been announced. The volume of coal that could be transferred through these ports may be constrained by area rail system capacity. The port at Vancouver, British Columbia, now has a capacity of 15 million tons per year, and could handle some Western coal. Seattle plans to expand its coal export facilities to 40 million tons per year by 1990, if export sales warrant such an investment. Other Western ports may also invest in expansion if the coal export market grows.[50]

[50] see Office of Technology Assessment, Coal Exports and Port Development, OTA-TM-O-8 (Washington, D. C.: U.S. Government Printing Office, April 1981).

Comments on Regional and State Transportation Factors

Powder River Basin

The Powder River basin is likely to supply an increasing percentage of Federal coal. In 1979, the Montana-Wyoming Powder River basin produced about 80 million tons of coal; 72 million tons of this came from mines containing Federal leases. About 160 million tons are contracted for 1990 from Federal mines alone (see ch. 7). Almost all of this coal will be consumed by utilities. Unless coal slurry pipelines are built, more than 90 percent of

Federal coal will be hauled by rail, If the three pipeline projects mentioned in figure 39 are completed by 1990, they would transport 75 million tons per year.

Texas and Iowa will be two principal consumers of Federal coal from the Powder River basin in 1990. Other States that have contracted for large amounts of Powder River basin coal include Montana, Minnesota, Colorado, Wisconsin, Michigan, Indiana, Ohio, Oklahoma, Wyoming, and Kansas.

A rough idea of the rail traffic these contracted tonnages represent can be calculated on the assumption that it requires one set of 100 cars making 100 trips to transport 1 million tons. Powder River basin contracted output from mines including Federal leases will require 16,000 unit-train trips. Traffic past any given point is doubled to take into account the returning trains.

Assuming that the average coal car makes 46 trips annually (7-day cycle time plus 45 days maintenance), this tonnage would require 348 unit trains with at least 34,800 hopper cars. The time that a particular community is disturbed by train traffic depends on the amount of traffic, time of day, and train speed. A town through which 25 loaded and 25 return trains pass daily will be disturbed from 1 to 5 hours depending on train speed. * It should be recalled that other traffic (some non-Federal coal but principally noncoal commodities) will also be using this rail system, thereby increasing the traffic.

BN, which serves the powder River basin, will have to expand its capacity if it is to handle 1990 coal traffic. Although most Federal leases lie within 15 miles of existing rail lines, roadway limits down the line from the point of origin may present bottlenecks in the future.[51] Obtaining sufficient rolling stock is less of a problem than upgrading and constructing adequate roadway. As was noted previously, likely bottlenecks have been pinpointed on rail lines running east from the basin through Nebraska and Iowa to Missouri and south through Colorado and Texas. Traffic through the southerly corridor could be eased by operation of two proposed 25-million-ton-per-year pipelines: the Texas Eastern (Wytex) line from Gillette to Houston; and the ETSI line from the basin through Oklahoma, Louisiana, and Arkansas. The Wyoming State Legislature passed a bill in 1974 specifically authorizing export of water through the ETSI line. This line has obtained the necessary rights-of-way, air-quality permits, and EIS clearance. It could become operational in the mid-1980's. Unresolved legislative and water-resource issues have impeded rapid development of slurry pipelines originating in the basin. The lack of eminent-domain legislation and a recent decision by the Governor of Wyoming that pipelines should be developed only if they use nonwater technologies are significant constraints.

Managing the transportation of 1990 coal production from the basin will require cooperation among Western railroads. The BN and Chicago Northwestern (CNW) recently constructed a line from Gillette to Douglas, Wyo., which greatly improves the basin's coal-export capacity. But CNW's coal haulage also depends on use of UP track that runs east-west through southern Wyoming. BN has refused to share a connecting line with CNW, which prevents that carrier from hauling coal east on the UP track. CNW has proposed to build its own connecting track, but has encountered strong opposition from local residents.[52] CNW, however, expresses con-

*This would represent an annual tonnage of 91.25 million tons. Towns on the BN's track in Wyoming, Colorado, Nebraska, and Iowa can expect this level of traffic. Towns south of Gillette may have more trains passing through on a daily basis, depending on Basin output.

[51] NETS, p, 33 ff. and fig. 3-2. NETS identified 67 congested rail links in the coal transportation network nationally. About three dozen of these bottlenecks were identified in the West along transport routes for Powder River basin coal. (NETS, fig. 3-2). However, NETS used 1975 data that did not take into account post-l975 rail investment beyond what was underway in that year. BN and other major Western rail haulers have significantly upgraded their mainlines since 1975 to meet heavier current traffic. The BN, for example, originated less than 19 million tons of coal in 197o compared with 80 million tons in 1980 and 100 million tons forecast for 1981, according to BN president Richard Bressler,

[52] Powder River Basin Resource Council, "WYOBRASKA Keeps Up the Pressure," Powder River Breaks, September 1981.

fidence that it will be able to realize its plans to haul approximately 45 million tons per year from the Powder River basin in 1990.[53]

Other Wyoming Regions

Wyoming will also produce coal from the Hanna, Rock Springs, and Kemmerer fields in southern Wyoming, At the present time, all of the coal produced in this region comes from Federal mines—23 million tons of production in 1979, Coal production from this region will increase during the 1980's. The UP serves these coalfields. The UP seems able to haul expected tonnage without difficulty from this area. Because there are more communities in southern Wyoming than in and around the Powder River basin and because UP carries other commodities, some communities may be adversely affected despite the comparatively modest coal traffic increases.

Fort Union Region of North Dakota and Montana

It is not cost effective to transport lignite far from the mining site. Lignite has the lowest energy value and highest moisture content of the domestically mined coals, These factors force utilities to burn lignite close to the mine site. All of the powerplants currently under construction or planned in North Dakota will burn coal at the mine site.

Only one operating powerplant–the Big Stone facility—consumed more than 1 million tons of lignite annually from mines situated more than 100 railroad miles away, This South Dakota plant designed and built special covered hopper cars for hauling lignite from Knife River Coal Co. 's Gascoyne Mine 350 miles away. The Milwaukee Road (Chicago, Milwaukee, St. Paul, and Pacific Railroad) owns and operates this 350-mile track over which two unit-trains pass daily, The Milwaukee's bankruptcy may result in cutbacks in service. The Milwaukee Road Trustee requested a new freight rate, which would increase the transport costs of lignite by 65 percent. The partners at the Big Stone plant rejected this because the trustee was unwilling to provide guarantees that any portion of the new rate would be used to maintain the roadbed between the mine and the powerplants. North and South Dakota have been spending Railroad Recovery Act funds to maintain this track, which is considered to be in worse shape than any other stretch in the Milwaukee system. Milwaukee applied to its bankruptcy court and to the ICC in May 1981 for permission to abandon this tract. The ICC will make a recommendation to the court on September 15, at which time a final decision will be made.

While Gascoyne production has not been constrained by transportation factors up to now, Knife River's New Liepzig project has been delayed indefinitely by BN's unwillingness to invest $20 million to $24 million to upgrade the track that would carry about 2 million tons per year to a powerplant in Mandan, N. Dak. Knife River wants to prorate the upgrading costs between itself and BN (which owns extensive mineral rights along this line), but BN contends that Knife River should finance all the costs. BN stands to gain little from this investment because the expected traffic volume is so small. On the other hand, Knife River has no other way to move coal from this site.

Colorado

Transportation factors play a major role in determining the market potential of Colorado coals. Transportation costs are an important variable because Colorado coal from underground mines must compete with cheaper surface-mined coal from Wyoming and New Mexico. Moreover, Colorado coal must be shipped over the Rocky Mountains to reach Midwest and South-Central markets, Mine operators in the Green River region, the State's largest producing area, complain that rapidly escalating rail rates are destroying

[53] Remarks of' Douglas A. c hristensen, Vice president for Marketing of C&NW Transportation Co., at the Coal Outlook Conference Charting the Future of Western Coal, June 8-9, 1981.

their competitiveness. The Denver & Rio Grande Western (D&RGW), which serves western Colorado, argues that its rates are fair considering the high costs of upkeep under difficult conditions, such as the Mofatt Tunnel that leads to Denver and easterly markets. Higher rates also reflect the cost of new sidings and the installation of CTCS, the railroad says. The D& RGW's continued ability to move projected expanded coal output from western Colorado to the front range is open to question despite the railroad's assurances. The Green River-Ham's Fork environmental impact statement (EIS) found that with 20 million tons of new annual production from new lease sales, about 75 percent of D& RGW's capacity would be used. One alternative that has been suggested by local governments and mine operators to expand coal transportation capacity in northwest Colorado is construction of an extension of the UP line from Rawlins, Wyo., to Craig, Colo. No such extension of the UP into D& RGW's service area has actually been proposed.

Other rail capacity questions are apparent. Until the Tongue Mesa Field and the San Juan coalfield around Durango are served by rail, it is unlikely that significant development will occur there. The Federal leases in the Coalmont Field of the North Park region probably cannot be developed until the abandoned UP line from Walden to Hebron is substantially upgraded. This line has sharp turning radii and steep grades. These improvements will probably not be made unless enough coal can be shipped from the area under long-term contracts to offset the costs.

Several coal mines in the Green River region truck their coal to railheads at distances ranging from 2 to 30 miles. This has created additional expense for the mine operators and road damage to certain highways. Conveyors and rail spurs are being evaluated by some companies to reduce truck use. One coal slurry line originating in Colorado has been discussed—the San Marco line from Walsenburg to Houston, Tex. However, the Colorado legislature has barred exportation of the State's water. This policy coupled with other demands on local water resources makes this pipeline an unlikely prospect without Federal enabling legislation or legal resolution of water-rights issues,

New Mexico

The OTA New Mexico task force estimated that total coal production in the State could increase from 14,6 million tons in 1979 to as much as 72 million tons by 1990 under favorable conditions. Of this number, about 55 million tons would be exported, mostly to utilities in California and Texas. Although New Mexico has traditionally exported more than half its in-State produced electricity to out-of-State customers, the emphasis over the next decade is likely to be shipping coal by rail.

The construction of the Star Lake Railroad in west-central New Mexico is a major factor in this increased production. This line would connect the Star Lake-Bisti area of the San Juan basin, which contains one of the largest untapped strippable coal deposits in the Western United States, with the Santa Fe main line at Prewitt, N. Mex. Five large undeveloped leases and 28 outstanding preference right lease applications (PRLAs) are found in this area, as well as large reserves of fee, State, and Indian coal. The 114-mile Star Lake line could carry almost 17 million tons per year by 1990, and, if fully developed, this area would be able to mine as much as 75 million tons per year. Production of about 8 million tons of coal from Federal leases in 1990 hinges on construction of this railroad, as does an additional 18 million tons from mines on land covered by PRLAs. Construction of the Star Lake Railroad has been delayed because of difficulties in obtaining all the necessary rights-of-way. However, progress has been made; a right-of-way over public lands has been approved. Several questions involving rights-of-way over public lands and individual Indian allotment lands remain to be resolved. About three miles of tribal trust lands and 25 miles of allotment lands are involved. It is expected that all necessary rights-of-way will be obtained. Construction would begin within a few years after the right-of-way issues are settled and would be completed within 2 years, according the the Santa Fe's estimates.

Other transportation issues are relevant to other coal development in New Mexico. Mine construction on several Federal lease blocks will require upgrading of local roads. A 230-kV transmission line would have to be constructed to link the proposed New Mexico Generating Station near Bisti with the existing electrical grid 209 miles to the southeast. Another proposed rail connection from mines on the Navajo reservation to the east-west trunk line at Gallup is also under consideration. The carrier—the Santa Fe—has acquired right of way to 22 miles and the remainder is under discussion. This line would carry between 4 million and 25 million tons per year if completed.

Utah

Most Federal leases in central Utah are located near existing road and rail transportation systems which appear to be adequate to handle future production. In this area, coal would be moved by truck, rail, or conveyor to the powerplant or railhead. Improvements and repairs to existing systems are underway. Some mines currently have to truck coal 60 miles to rail connections, but this does not seem to have been a constraining factor in mine development, This truck haul would be reduced when the planned Castle Valley Railroad extension is constructed.

Southern Utah, on the other hand, does not have a well-developed transportation system serving potential coal mining areas. Two coal slurry pipelines 180 miles long would connect the Alton Mine to the proposed Allen Warner Valley Power Project. The slurry plan conflicts with Utah law restricting transfer of water out of State, The Kaiparowits Plateau Field is not currently served by rail or major roads. Coal development there depends on construction of a rail or slurry line to move coal to market, A minimum of 30 million tons of annual production is required to offset the cost of building a rail line from the plateau. Such a rail line has been under study, but no date has been proposed for its construction.

Oklahoma

Oklahoma's coal production, currently at about 5 million tons per year, is not projected to increase substantially over the next decade. Utilities in Oklahoma buy coal from other States, principally Wyoming, because of its low-sulfur content. Oklahoma's high-sulfur steam coal is exported to generating plants in other States that have less restrictive air pollution requirements. Oklahoma's metallurgical coal markets depend on demand rather than supply-side or transportation factors. Much of Oklahoma's current production is trucked to rail and barge centers throughout the region. County roads and bridges adjacent to Federal coal properties are typically in poor condition and some cannot accommodate heavy commercial traffic. Coal industry spokesmen have expressed a willingness to build new roads or repair existing ones. Rail lines to major rail and barge connections are ill-suited to transport large quantities of coal efficiently, but should prove sufficient to handle expected output with some upgrading. One Oklahoma coal operator has stated that the "only way that is economically feasible (to export Oklahoma coal) is by barge; the rail rate is simply too high."[54]

[54] OTA correspondence with J. F. Porter, III, Vice-president of Garland Coal & Mining Co., February 1981.