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TRANSPORTATION OF ENERGY MATERIALS

modes
1 highway transportation
3 rail transportation
5 other

subject areas
12 planning
15 socioeconomics
21 facilities design

CONTENTS

FOREWORD

By C. H. Oglesby, Chairman of Section B, Group 1

The 1979 summer meeting of Section B of Group 1 with the cooperation of Groups 2 and 3 centered on the theme Transportation of Energy Materials. Energy is today a critical issue. Much attention has been focused on energy production, conversion and use, but less on the many problems of moving the energy producing agent or the energy itself from its point of origin to the point of conversion or use.

The aim of this conference was to bring together persons knowledgeable on several facets of this complex topic in order to present the state of the art and air some of the principal issues. In turn, subjects for badly needed research would be developed for subsequent TRB activities both by the conference participants and those who receive this publication.

This curcular contains the formal papers presented at the conference, a summing up, and a few of the insights from panel and other discussions. It does not claim to cover all aspects of such a complex problem.

But it does raise many of the economic, financial, political, and legal issues on which research is needed. The conference was conceived by Ed Margolin. Planning and carrying it out to a successful conclusion was done by a special subcommittee shown in the acknowledgements, and chaired by Ed Margolin with the invaluable support and assistance of Floyd Thiel and E. J. Ward of the TRB staff.

MEETING OBJECTIVE

By Edward Margolin, Consultant/Lecturer

Thank you Clark for your very kind remarks. This conference on the transportation of energy materials grew out of a concern for the new issues arising in the transport of energy materials caused by the need for new sources of fuel and the escalating prices in energy. Availability also necessitated an intensive discussion of the movement of these materials, now and in the future, to gain from further insights, to stimulate needed research, and in general to obtain a better perspective of the issues to be confronted. The meeting is intended to examine transport of energy materials by all existing surface modes and new technologies which may provide the basis for additional modes in the future.

We have assembled a fine group of talented experts to discuss these issues; we ask your full participation.

I want to take this opportunity to thank the members of the Subcommittee who worked so diligently to consider the need for TRB involvement in this area and for their assistance in the preparation for this conference. I also wish to thank the TRB staff, including the staff representatives from Groups 2 and 3, Bob Welch and Adrian Clary.

KEYNOTE ADDRESS: TRANSPORTATION AND ENERGY

The Honorable Bud Shuster, U. S. House of Representatives and Chairman National Transportation Policy Study Commission

Today the U.S. has the finest transportation system in the world - today the U.S. is facing a transportation crisis.

The plight of transportation in this country is a result of over regulation and a dampening of the competitive spirit. The Doyle Report almost 20 years ago, identified fundamental problems as a lack of adequate information; lack of continuing research; lack of a program approach and organization in the government; and the need for a complete redirection of transportation pricing philosophy. This wasn't the first time problems and needs of the transportation sector had been identified; it was however, another example of our failure to respond expeditiously and intelligently to demanding issues. For now, nearly a generation later, the National Transportation Policy Study Commission is ending its study, and we have determined that the old problems are still with us, compounded by even more unsettled perplexities. We are additionally faced with an energy shortage, increasing demands on our transportation network and perhaps the most serious problem of all, a ponderous proliferation of inequitable regulations. Thirty Congressional Committees, 64 Federal agencies and a mindless acceptance of governmental intervention, have combined to produce over 1000 programs and policies misguiding our transportation system. Congressman Jim Howard and I, responding to public concern, sponsored the 1976 Federal Aid to Highways Act which mandated the National Transportation Policy Study Commission. The Commission's three year task was to examine all modes of transportation for needs and ability to meet those needs through the year 2000. Special emphasis was placed upon examining existing Federal programs and suggesting new policies to develop a balanced system designed to anticipate our growing requirements.

In carrying out the mandate, one crucial fact became evident: the current shortage of transportation services, capital and facilities will become even more acute by the 21st century. We can not wait another twenty years to adopt logical, rational programs and thus repeat the mistake we made in the areas of energy, environment and other crucial policies. The Transportation Research Board has the responsibility to rally behind a unified national policy supporting fair competition, reduced regulation and equitable pricing. Not just because that is the intent of our free enterprise system but because as people, a nation, we need your leadership in the private sector.

The National Transportation Policy Study Commision (NTPSC) Final Report makes policy recommendations based on indepth study, input from some of you and your colleagues, and identification of current issues and forecasts. There are those who feel the changes proposed by the Commission don't go far enough in suggesting reform and some feel they suggest too much change, too much restructuring. If those who are opposed can put aside their selfish interests and participate willfully and ethically in dynamic capitalism we will soon find regulations and modal jealousies a phenomenon of the past.

To allow you to better understand the NTPSC's conclusions and recommendations I will briefly review its mission and approach. Composed of 19 members, six from the House of Representatives, six from the Senate and seven public members appointed by the President, the Commission was mandated to examine, evaluate and analyze the nation's transportation needs and resources through the year 2000. In addition, NTPSC was to make recommendations for a responsive, efficient and cohesive national transportation policy.

None of the past government reports, which date to the Windom Report of 1874, has attempted to identify transportation needs through a concise integration of empirical findings, current status and projected trends spanning the entire spectrum of our transportation network. The Commission first developed a detailed plan composed of 19 major tasks which were later grouped into five study areas.

The first of the Commission's major study areas - identification of the key issues confronting the transportation system in the U.S., analyzes and evaluates these issues with respect to their significance to potential national transportation policy initiatives and impacts. To accomplish this, previous transportation problems and proposals were identified through a comprehensive literature search. Additionally surveys and public hearings were conducted in various cities around the country. These produced a compendium of current transportation issues.

The second NTPSC task was to compile and assess current transport policy. Much to our amazement we identified over 1000 transportation policies and programs formulated and administered by 64 Federal agencies and 30 Congressional committees. Not surprisingly, we discovered that many of these programs are contradictory.

The third task was to create models based on the history of growth, consumption and problems of our transportation system. These scenarios were then carried out to the year 2000. The resulting wealth of information permitted forecasting of future demands on and by our transportation network. The unquestioned conclusion is that our current situation will be greatly compounded if we do not soon take positive actions.

Total national domestic person miles of travel are forecast to increase from 2.57 trillion in 1975 to 4.5 trillion in 2000, and may reach as high as 5.04 trillion. This represents increases of 81 percent and 96 percent respectively. At the lower figure, the urban local market leads the growth with a 95 percent increase while under the higher scenario the intercity market will lead the growth with a 119 percent increase.

Total national domestic freight ton miles are forecast to increase from 2.361 trillion in 1975 to 6.264 trillion in 2000, and may reach as high as 7.687 trillion. This represents increases of 165 and 226 percent respectively, with the urban market leading the growth in both cases with increases of 207 percent and 314 percent respectively.

These projections are the result of a major forecasting effort. Three scenarios were developed, each assuming certain basic conditions. By inserting various indicators the formula provides a plausible glimpse into America's transportation future. Known factors include substantial growth of person and ton miles, and expanding labor force and a rise in the number of households relative to population. Our ability to meet these growing demands depends upon our seriousness of commitment. Continued procrastination and piecemeal reform will manifest debilitating shortages by the turn of the century.

Our fourth and fifth tasks were the formulation and testing of policy proposals. Unlike previous studies, the Commission's report attempts to group its recommendations into a policy package and then to analyze and evaluate the impact of those proposals on the system.

Before turning to the Commission's recommendations it may be enlightening to recognize the enormity of our transport system. Almost 20 percent of our gross national product is derived from transportation; 80 percent of eligible Americans have drivers' licenses; over 240 million travellers took to the air in 1977 alone; we have 200,000 miles of railroad line, 25,000 miles of navigable inland waterways, 14,000 airports; the transportation sector, both private and governmental, employs a combined total of 6 million Americans. It is only the diverse nature of each mode and isolation of their problems that has kept us from recognizing the severe impact a reduction in transport abilities would bring. A unified transportation policy should be our first priority.

The recommendations of the Commission can be separated into 5 functional areas. The first is that of regulation. Any future policy must involve a uniformity of government regulations. Certainly unique aspects inherent to each mode require unique solutions, nonetheless regulation should not work at cross-purposes. It is imperative that we provide adequate service, achieve more efficiency and promote safety in a cost-effective manner. Attempting to reach these goals with our present system has produced a quagmire of regulatory oppression, to the point of being anti-competitive. To remedy this, the Commission recommends a substantial, though certainly not total deregulation of the rail and motor freight industries. Specifically, it recommends easing entry requirements and establishing a zone of reasonableness for rate making.

The second area of deep concern is governmental ownership and operation of transportation facilities and services. The Federal government now directly owns or operates a myriad of transport activities including the Corps of Engineers dredging operations, FAA's air traffic control system and the St. Lawrence Seaway Development Corporation. Federal funds are used to permit other levels of government to own or operate such facilities as highways, urban transit, airports and selected rail branch lines. This produces the paradoxical circumstance of government agencies and actions competing with private sector firms in a free enterprise system. Clearly this is an untenable situation. Any attempt at immediate divestiture would prove calamitous. Therefore we must seek technological change, innovation and cost-effectiveness to show that market forces are far superior to political processes in business management.

Finance, pricing, and taxation are points of much debate as well as the Commission's third major study area. With the unquestioned need to maintenance and rehabilitation, some form of equitable fee collection is mandatory. It is estimated that within the next twenty years we will need as much as four trillion dollars for capital investment and maintenance. Presently, Congress provides some capital grants, subsidies and operating assistance and oversees management of trust funds for various modes. These present programs unfortunately, are not meeting demands. As the shortcomings become acute additional means of raising funds is necessary.. Of the total capital needs, through the year 2000, it is projected that various levels of government will be required to spend $1.242 trillion and may need to spend as much as $1.292 trillion. For the year 2000 itself, total federal, state and local government transportation outlays are projected to be $105.4 billion in constant 1975 dollars, and may range as high as $109.7 billion as compared to $37.06 billion in 1975.

Of the total government transportation outlays in the year 2000, it is projected that general revenue requirements will be $70.8 billion and may be as high as $72.8 billion as compared to $17.5 billion in 1975.

The effectiveness of any unified transportation policy will depend upon a program of planning and information, NTPSC's 4th study area. Status quo policy provides little effort to publicize or integrate results of categorical planning by the Federal government. Rather, separate programs are pursued. For example, social service programs of HEW require the availability of transportation. In

this case and many others, no coordination with state and local transportation officials is attempted, much less cooperative planning with the Federal Department of Transportation.

Perhaps one cause of state and local problems with the federal government is the high cost of federally mandated planning methods. Designed for federal purposes these procedures make unreasonable demands on limited budgets. I believe the federal government can best serve as an effective clearinghouse for information in this area. The availability of a national data bank would reduce the ponderous quantity of state and local studies initiated yearly and enhance cooperation among all levels and agencies of governments.

The fifth area of Commission recommendations is government organization. We have recommended that the ICC, FMC, and CAB should be abolished and a single regulatory commission be established to perform the residual functions of these agencies. We have also recommended that the DOT be strengthened to become the lead agency in all federal programs when primary objectives are transportation oriented. In addition to these areas of study, the Commission also did an indepth study of the two faceted relationship of transportation and energy. First, is the energy transportation consumed and secondly the transportation of energy. Both will continue to have dramatic effects on our economy. As is readily evident there is a shortage of gasoline at the pumps. Because the transportation sector will depend upon petroleum as its primary energy source for the foreseeable future, the movement of energy forms may be in jeopardy. Certainly our 440,000 miles of pipeline will aid oil movements but we are also faced with growing demands for coal, problems in transporting nuclear waste and of course waterway, railway and tanker transport of petroleum to areas not served by pipelines. The major transportation issues that result from the need to adequately distribute the nation's fuels to the transportation sector and all other users must be identified if we are to attempt solutions. NTPSC quantifies six such issues:

1. Upgrading and expansion of the railroad network.

2. Supplementing bulk interior rail transportation with improved waterways and by slurry pipeline.

3. Equipment improvement of bulk facilities at ports.

4. Study and provision for increased local coal haul on our nations highways.

5. Increased use of off shore petroleum and Colorado Plains coal and

6. Acceptance of a long range nuclear waste handling, transporting, and storage policy. Without a comprehensive national transportation policy these questions of energy availability will severely compound the deficiencies our transport network is facing. By recognizing and attaining free market capabilities, the industry should be able to cope with future demands.

Historically, while society has enjoyed and proclaimed the benefits of transportation opportunities, the environmental consequences of transportation activities have frequently been ignored or misunderstood. Until perhaps the last decade, environmental concern over transportation activities has been slight. Since the mid 60's we have witnessed a proliferation of environmental regulations, many with severe cost of operational consequences for the transport sector. Strong support is found in all segments of American society for environmental protection. Nevertheless, demands on the economy and supply of energy often compete with environmental endeavors for limited resources. It is time to examine very closely new means of environmental protection that will not damage our economy and add to the misuse of our energy reserves. Clearly the next 2 decades will see continued economic and energy pressures. More direct trade-offs will be confronted in solving environmental problems. Congress, the administrative agencies, industry and individuals will increasingly need to turn their attention to deciding these trade-offs on a case by case basis for each transportation-environmental problem. As industry leaders it is your responsibility to consider environmental impacts when establishing methods and practices of doing business. Perhaps with more concern on your part reduction of certain government agencies will be possible.

My tenure as Chairman of the National Transportation Policy Study Commission has been an experience both enlightening and worrisome. Knowledge of the history of our transportation network, its capabilities, needs, benefits and problems will make achievement of a unified transportation policy more realistic. However, I am also deeply concerned about the ability of current transportation resources to meet future demands. What was intended to provide fairness among competing modes has now become a regulatory nightmare, inhibiting business, stifling competition and fostering wasteful and duplicative expense.

I believe the Federal transportation structure must be strengthened and streamlined for managerial efficiency and to eliminate the costly burdens that redundant federal agencies and rules impose on the private sector and on state and local governments.

Our choices are not easy or even obvious, but we have identified the problems and now it is time to let free-enterprise function in the market place with minimal governmental intervention. We of course must provide for equitable distribution of our scarce resources but that is best accomplished by accentuating the positive and eliminating the negative.

Thank you for asking me to address this distinguished association and your guests; it has been a pleasure.

THE RAILROADS AND THE ENERGY CRISIS

John E. Murray, Association of American Railroads

The energy crisis to the railroads is like a Get Well Card from an undertaker. We have mixed feelings about it.

There are opportunities with troubles. And also troubles with the opportunity.

And I would like to talk about them from the railway viewpoint.

I will cover consumption, conservation, costs and supply of energy to the railroads. And then movement of energy by the railroads.

Consumption

The railroads consume over 4 billion barrels of #2 distillate fuel a year. This fuel flows into 27,000 locomotives with 4,000 gallon tanks. This seems like a whopping lot of Btu's. But consider...

In using this fuel the railroads move over 870 billion ton-miles yearly. This is 37 percent of the intercity freight, and 3% of the total amount of the energy consumed by the country. A whiskey shot glass holds an ounce of liquid. An ounce of diesel fuel in that shot glass put into a locomotive will move 1 ton 1 mile!

Railroads -- the wheel on steel -- is in fact more economical in fuel than any form of transportation. Railroads move 8 percent more traffic and use only 4 percent more fuel than barges. (1, 2)

The unit train is even more energy efficient than pipelines as well as barges. The energy intensiveness in fact of the unit train -- 2.38 gallons per thousand ton miles compared to 2.61 gallons for inland waterway for freight movement and 4.33 for oil pipeline.

As a result of thrifty train use of fuel, railroad operating costs for fuel are less than that of the competition. Railroad fuel costs now average 10 percent of operating costs with trucks at 20 percent and higher and with barges up to 35 percent.

Conservation

It is becoming more apparent that even with the railroads' well known fuel thriftiness, there is a conservation contest going on with competing modes. It may well rage into the future.

Therefore railroads have been concentrating on fuel savings from the Operational, Mechanical, and Research & Test viewpoint. And we have also been emphasizing recycling.

Operational savings have developed from improved inventory, security, reduced spillage and adjustment in storage locations. Locomotives are being shut down during layovers, the "low idle" option is being installed in new locomotives and idling is being cut by oil fired or electrical plug-in heaters. Fuel consumption calculators, computer simulators, and speed reductions are also paying off in less consumption.

Lightweight Trailer on Flat Car (TOFC) cars, the "Road-Railer" and the double-decker Container on Flat Car (COFC) car are fuel savers under adoption, or test.

In the Mechanical area, low-friction roller bearings seals, reprocessing of used oil, use of additives and improved injectors on locomotives have all been used to save fuel and improve operations.

Some solar power is in use providing Btu's for signal circuits and microwave repeaters.

Research and Test work is going on in fly-wheel energy storage and the retrieval of the energy dissipated in slowing freight cars moving down humps in classification yards.

As to alternate fuels there has been some experimentation with Methanol and the Canadian National has been running diesel engines on crude oil refined from tar sand.

Some work has been done on aerodynamic drag. And for the long pull the Department of Energy appears to be interested in hydrogen locomotive fuel.

Energy savings are also accomplished by recycling. Ties have been shredded to wood chips for boiler fuel. And some are reused in branch lines and sidings. Paper is sold, and metals are reused or sold for reclamation.

It is our feeling that much additional conservation benefits of a secondary or tertiary nature are being reaped but go unheralded, by railroad suppliers. Tallied they would help to more fully enhance the railroad industry status in the eyes of the energy conscious public and also assist railroad management in its stress on energy conservation. The "two-wear wheel" is a good example.

Cost

As has everyone else, the railroads have endured skyrocketing fuel prices. Since 1 October 1978 when we had our last general rate increase that included fuel, we lost over $200 million.

We now have to jump over two administrative hurdles: COWPS (Council on Wage and Price Stability) and the ICC (Interstate Commerce Commission). And the time lag in obtaining pass through of the cost of fuel is increasingly costly. Today's highest price is tomorrow's average. And we never recoup our losses.

Our average price a gallon now is about 62¢. The main problem with prices is that we do not recoup the losses that occur because of regulatory lags in approval of them. But we are working on it.

The ICC has set up an automatic increase procedure for pass through of the truckers' rocketing fuel costs. Perhaps because the railroads don't have the ability to circle the White House, railroads are confronted with procedural delays and have to chug through a heavy sludge of paperwork before price increases are considered.

However, the ICC has recognized the railroads' plight and has approved a 10 day pass through procedure. We are hoping for 4 days. Given the abysmal rate of return of the railroads (1.26 percent last year) and the soaring fuel prices, the fairest way would be approval of prospective price increases. But that, given past history, is no doubt expecting too much.

There is no justification for the glaring preferential treatment accorded the trucking industry. In its June 29, 1979 order, the Commission attempted to excuse its discriminatory actions by alluding to the trucker owner-operator emergency. However, the almost instantaneous fuel cost pass throughs the ICC permitted applied to the entire motor carrier industry, not just to the owner-operators. The ICC also referred to the "nationwide impact" of a railroad rate increase as a reason for its reluctance to provide a quicker price increase pass through. The purported distinction excapes us. The trucking rate increases imposed an identical impact on shippers. These increases are nationwide as well.

The ICC's action cannot be rationalized. An emergency exists for both railroads and trucks and the same relief should be accorded both. Indeed, the railroads, with their limited resources, are probably less able to bear the harsh impact of these runaway fuel prices.

Supply

While higher prices are irksome, they do not rival the concern railroads have for diminishing supply. We are depleting inventories, buying on the exorbitant spot market, juggling and shifting supplies in tank cars, obtaining some small relief from States' emergency set-asides, and sadly curtailing service. But railroads can go only so far with inventories and ingenuity. At the moment the most serious curtailment for lack of fuel is the embargo of traffic between St. Louis and Kansas City, by the Rock Island Railroad.

While the Administration has said it deplores rationing, and the word is taboo, that is what is happening. The "build up" of the Defense Petroleum "Reserve" is a ration. The 240 million barrel "set-aside" of middle distillate for home heating by October's end is a ration. The ERA (Economic Regulatory Administration) ordered the increase in gasoline production by the refineries, which reduced the middle distillates -- such reduction was another form of rationing. ERA direction of an "allocation" of reduced levels of middle distillate to users by oil companies is a ration. And so was the infamous Rule 9.

The Administration trhough the DOE's (Department of Energy) ERA did ration middle distillates to: agriculture, oil and natural gas producers; mass transit and truckers hauling agricultural products.

The available fuel supply got less, while the railroad traffic increased and a large part of that increase was in the movement of energy and in support of agriculture.

Hence the irony -- the most fuel efficient form of transport penalized by Federal Government bias in favor of less fuel efficient users. In the name of saving fuel, more fuel is being used!

Movement

The railroads are big in the energy movement business. With a fleet of 359,000 coal hopper cars having a replacement value of $14 billion, railroads move about 70 percent of the nation's coal. With an additional 12,000 cars on order reflecting an investment of $480 million we can keep up with the nation's needs.

In addition to coal we move practically all the spent nuclear fuel, and much of the nuclear waste and rocket fuel. The railroads transport about 475,000 carloads of petroleum products yearly. 25 percent of this is liquid petroleum gas. 20 percent is residual fuel oil. It's perhaps wise to recall that 35 years ago the railroads moved a million barrels a day of fuel from the Southwest to the East Coast, and Mobil Oil has now rediscovered the tank train that moves fuel from New York to New England cheaper than by barge.

Coal hauling has not increased as expected, mainly due to a number of uncertainties about environmental rulings by the EPA, the high cost of scrubbers, the unpredictability of nuclear power plant development, the use of natural gas vs. oil and coal, and an apparent general reluctance to change. Rail rates have been cited as reluctance contributors.

However, there is more emotional bias about coal rates than fact. The fact is the delivered price of coal in a decade has risen from over $7.50 per ton to almost $29 a ton, a 400 percent increase. But the average rail rate for coal rose less than 145 percent.

Nationwide rail coal rates average 1.51 cents a ton mile, whereas all commodities as a whole average 2.36 a ton mile. Contradictory as it may seem while more coal may be mined, less will be transported over long distances. The traffic demand for coal movements may not be as large as many anticipated because the coal movement market was recently shrunk by Federal edict.

The Environmental Protection Agency without saying it virtually ruled that twenty-nine million tons a year of Western coal will not move to the East. The ERA reversed a former ruling that had permitted low-sulphur coal to burn without scrubbing.

Now since all coal must be scrubbed for sulphur dioxide, there is no advantage for users in shipping low sulpher coal to cities in the East or Midwest that virtually sit on high sulphur mines. Either way they've got to scrub.

Furthermore there is no question that the railroads can move all the coal traffic that can conceivably be produced. Coal is the railroads' staple. Every fourth ton the railroads move is coal. And they can get cars and locomotives and lay new track far faster than new mines can open.

The Bureau of Mines (3), a combined study for the former Federal Energy Administration, the Department of Commerce and the Department of Transportation (4), a separate special task force of the Department of Transportation (5), and the Congressional Office of Technology Assessment (6); all four agreed that the railroads could handle the increased coal traffic. After all in the unlikely event that coal traffic is doubled over ten years, it would mean only a 20 percent increase in railroad traffic. In two recent years (1972-3) rail traffic went up 15 percent. The railroads exerted little extra muscle to meet this surge. It can certainly do in ten years what it can almost do in two.

Thus, it is readily apparent there is a rescue option to being ravaged by OPEC. The way of redress is the railway.

Promise!

The dual shadows of energy shortage of inflation threaten to blot us out. It would be utterly rash to pretend to offer a magic way to totally off-set this dire event. There is probably no single way. But one of the ways to prevent eclipse by these twin terrors is the railway. The nation's railroads as austere users and mammoth movers of energy at low cost won't wipe out inflation but they can help.

As a sign of conservation sense, for instance, New England Power at Brayton Point, Massachusetts -- a plant that now consumes 15 percent of oil consumption of all the utilities in New England -- will soon begin converting that plant to coal. On completion this will save the nation and New England almost 11 million barrels of oil yearly.

Keep in mind who the railroads are. And who we are not. We are not a monolithic monopoly. Among other obstacles railroads are presently struggling with regulatory structures and strictures that should fall to a de-regulation design based on a Railroad Bill of Rights.

In sum the railroads pay a social dividend, relieving highways of congestion noise and high risk and above all in saving energy.

The railroads consume a piddling amount of energy for a powerful lot of work. They conserve energy both in its use and in their use by others. They pay a high price for energy, but not as high a price as a barge or truck, since the railroads consume less in moving more.

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WATER TRANSPORTATION OF ENERGY MATERIALS

Algernon H. Johnson, Director, Minnesota Energy Agency

The nation's recognized navigation system is composed of 26,700 miles of inland and intracoastal waterways, the Great Lakes-St. Lawrence Seaway system and the ports and harbors serving these waterways. Providing direct access to 131 of the nation's largest cities and to almost all of the contiguous states, transporting energy resources along these waterways involves innumerable issues and problems.

The following discussion will focus primarily on the movement of coal on the Mississippi River system and the Great Lakes--the current picture, future developments and the industries' ability to respond to expanded use. The need for deep water ports on the West Coast to accommodate super tankers hauling petroleum from Alaska's North Slope will also be briefly discussed.

Although this encompasses only a small part of the total picture, the issues surrounding these areas are the ones that must be addressed and resolved now, as they are the ones most crucial to the nation's immediate energy needs.

Recent changes in oil prices and President Carter's energy message point to some important shifts in the use of coal and oil in the U.S. Carter's ceiling of 8.5 million barrels per day for imported petroleum will likely result in a substantial shortfall between increasing demand and decreasing supply. Potential increased domestic oil production will probably only partially compensate for reduced imports.

Carter also called on utilities to reduce by 50 percent the amount of oil used to generate electricity. Although he did stress the need to have nuclear-fired generating capacity in the U.S., his message implied a go slow policy until safety questions are resolved.

All of these changes point to an increased demand for coal--coal for electrical generation, coal for the development of synthetic liquid fuels, and coal to replace oil in industrial processes. Substantial deposits of domestic coal are available in Appalachia, the Illinois basin and the western states of Montana, Wyoming and North Dakota. The inland waterway system and the Great Lakes are expected to play an important role in transporting this increasing volume of coal.

Transportation on the Mississippi River System

The Mississippi River, its tributaries and the Gulf Intracoastal waterway network are essentially one inland waterway system that carries most of the nation's waterborne cargo. This system comprises about 55 percent of the length, 70 percent of the ton-mileage, and 85 percent of the total tonnage of waterborne traffic in the U.S.

The Mississippi River system is the largest and most improved component of the inland waterways. Barges move approximately 123 million tons of coal per year as well as significant amounts of petroleum along the 9,000 miles of navigable channels. In total, coal and petroleum account for about 60 percent of all transportation on the river.

The Lower Mississippi system, between the mouth of the Ohio River and Baton Rouge, has the largest amount of traffic, transporting more than 90 million tons of cargo per year. In the Upper Mississippi system, barges transport 56 percent of the Upper Midwest's grain exports, 41 percent of the area's fertilizer, and 28 percent of its refined petroleum products. In addition, electricity derived from barge-transported coal serves about one of every three persons residing in the Upper Mississippi River Basin.

Currently, shipment of coal to Florida via the inland waterway system is being considered as a possible alternative to more costly rail shipments. Because the rail line grades from the Appalachian coal mines are designed for northbound traffic, it is extremely expensive to ship coal south to Florida. It is estimated that ten thousand tons of coal can be transported north for every thousand tons transported south. In fact, it is actually cheaper for Florida to import coal from South Africa or Australia.

A preliminary study of the cost figures shows that moving western coal to the Mississippi via unit train, transferring it by river barge to New Orleans and then by ocean barge to Florida, would definitely be less expensive than rail shipment from Appalachia and may also be cheaper than importing African or Australian coal.

With the exception of lake carriers, transport on inland waterways has generally been found to be

more fuel-efficient than other modes of transportation. The Department of Transportation has estimated that one gallon of fuel will move 300 ton-miles of freight by water, 180 ton-miles by rail, and 50 ton-miles by truck.

For this reason, barge rates are generally lower than rail rates (0.4 to 0.7 cents per ton-mile). However, if river transportation is used only for a short distance, or if the river route increases the total distance the coal is shipped, an all rail movement may be cheaper.

According to a 1976 study by the Electric Power Research Institute (EPRI), there are four constraints that limit the annual throughput of the inland waterways system: operating season, channel depth, channel width and locks.

Operating Season

The Upper Mississippi River and the Missouri River are the only two waterways that have restricted operating seasons. The former operates 8.5 months a year; the latter, 7.5 months.

Channel Depth

The typical river barge and towboat can operate on all rivers with a channel depth of 9 feet. In the Lower Mississippi system, channel depth generally exceeds 9 feet, while in the Upper Mississippi system, dredging operations are often required to maintain a 9 foot depth.

Channel Width

Although some narrow sections of the river limit the number of barges that can be moved at one time, there is generally no practical capacity limit in the open stretches of the waterway system. Most barges are about 200 feet long and 35 feet wide. Unless restricted by physical characteristics of channel width or river velocity, one towboat can handle up to 30 barges.

Locks

The major constraint to current inland waterway traffic is lock capacity. The length of a tow, including towboat, can be almost equal to lock length (or double the lock width). The longer the tow, the more time is required for it to traverse a lock, which can result in traffic congestion.

River operators consider that a lock is reaching capacity when average delays reach six hours per tow. Currently, delays of six hours or more are occuring at several locations in the Upper Mississippi system, especially at Lock and Dam 26 at Alton, Illinois.

River traffic is growing at an annual rate of three to four percent per year. The barge industry has the capacity to double the number of barges and towboats in a relatively short period of time and should be able to respond to increased demands very quickly. This assumes that congested locks such as Lock and Dam 26 are improved and other handling facilities are built.

Another potential problem is the threat of increased transportation costs due to user charges such as a fuel tax or toll. The Federal Government is currently considering the user charge as a means to offset maintenance costs.

At this time, the Mississippi River enjoys the lowest operation and maintenance cost per ton-mile (less than half the system average) of any segment of the inland waterway system. It is estimated that the impacts of a user charge on the Upper Mississippi River system would increase barge rates about 15 to 20 percent on the average. A recent study by the University of Minnesota Department of Agricultural and Applied Economics suggests that user charges may increase the barge traffic on the Upper Mississippi by diverting it from higher cost segments of the inland navigation system such as the Missouri.

In any case, the user charge is a controversial issue which has raised such questions as: how will it affect the competitiveness of water transportation relative to other transportation modes?; would it cause major shifts in traffic patterns?; and how much would a "viable" water transportation system cost the taxpayer?

If user charges greatly increase total transportation costs, some traffic would no doubt be diverted to trucks and railroads. This potential result must be seriously considered, both in terms of overall transportation needs and, because barges are more fuel-efficient, in terms of the nation's overall energy situation.

Transportation on the Great Lakes

In 1977, the Great Lakes carried approximately 40 million tons of coal and lignite and about 9.5 million tons of crude oil and petroleum products. By 1978, total U.S. tonnage moved on the Lakes was 169 million net tons; a 21 percent increase over 1977, in spite of the iron ore miner's strike during the fall.

The Great Lakes have a surface area of 95,000 square miles and 1,700 miles of navigable water connecting the system to the Atlantic Ocean. In the past, a large volume of coal was moved from the east to the west via the Great Lakes. Today that system is being reversed, due primarily to environmental and economic concerns.

Eastern coal has a higher sulfur content compared to western coal. Also, according to a 1976 estimate by the Bureau of Mines, approximately 80 percent of our nation's demonstrated reserve base of 438 billion net tons of coal is located west of the Mississippi River. Montana and Wyoming contain over 40 percent of our demonstrated reserve base and about 80 percent of our country's low sulfur coal.

Because of its abundance, low sulfur content, and inherent economic advantages western coal is being relied upon to provide a major portion of the nation's energy needs. This is particularly true for the energy-poor Eastern and New England states.

Over the next 25 years, the Great Lakes is expected to play a vital transportation role in the tremendous resurgence of coal usage. The major growth will be in the intermodal movement of western coal to the Eastern areas of the country.

Unit coal trains leaving the western mines are typically 100 to 110 cars long. Equipped with automated loading and unloading functions, they can be unloaded at modern transshipment facilities in less than four hours using automated single or double car dumpers.

The coal transshipment facility at Superior, Wisconsin is representative of state-of-the-art facilities today. Constructed by the Detroit Edison Company, the automated unloading process at Superior is completed in just over two hours on the average. The coal is reloaded into a 105 foot by 1,000 foot collier at the rate of 10,000 tons per hour.

The Superior facility also includes such environmental and safety features as dust suppression and

collection systems, water treatment and spark-free motors.

Aside from another transloading facility at Thunderbay which has a loop track to facilitate train movement, there are very few, if any, facilities on the Lakes designed to receive and handle coal in the same way.

The economic advantages of high volume, low water transportation freight rates combined with low unit train rates are readily evident. A modern intermodal transportation system could deliver western coal to Buffalo, New York, today at a lower price, on a Btu basis, than the FOB price TVA recently paid for 15 million tons of high Btu, low-sulfur eastern coal.

In addition to lower transportation costs per ton-mile and greater fuel efficiency, the water transportation mode via the Great Lakes eliminates the major environmental problems of unit trains hauling western coal eastwards. A 1,000 foot collier with a capacity in excess of 68,000 net tons can carry the contents of six 110-car unit trains. Bypassing all metropolitan areas, transporting coal via the Great Lakes eliminates noise pollution and community disruption.

The main obstacles to navigation on the Great Lakes are the narrow and shallow connecting channels between lakes. The Illinois Waterway that joins Lake Michigan with the Mississippi River and the channel in Oswego, New York, where the Hudson River Waterway enters the Great Lakes, are typical examples.

Constraints to expanded shipment of coal on the Lakes include limited availability of equipment, the need for up-to-date facilities and the capital expenditure needed to remedy these problems.

According to the EPRI study previously mentioned, the existing Great Lakes fleet is already committed and the number of ships that could be made available for hauling coal is limited to new vessels currently under construction. There are three new ships under construction for hauling coal in the Great Lakes. These ships will be able to carry 50,000 tons per trip, 40 trips per year; or 2,000,000 tons per year. Approximately ten new ships could be constructed per year. Thus, 20 million tons of annual capacity could be added.

A related issue is that of tanker sizes and lock capacities. To efficiently transport increased volumes of coal, larger vessels will probably be required. Current studies on tanker size suggest that the optimum size for lake vessels is 140 feet by 1,200 to 1,300 feet. Although 1,500 foot vessels have been studied, it is estimated that fuel efficiency would decrease significantly.

To accommodate vessels of this size, locks would have to be modified or replaced. Of the four Sault Ste. Marie locks, only one--the Poe Lock--is long enough to accommodate even 1,000 foot vessels. Given the increased tonnage anticipated from western coal and iron ore pellets in the super colliers, the U.S. Senate has authorized a study by the U.S. Corps of Engineers on the need for and feasibility of a second, modern lock to replace the Sabin or Davis Lock, or perhaps both.

In addition to the cost of updating or replacing these locks, the fixed cost for a super collier is high. A new self-unloading vessel belonging to the American Steamship Corporation cost about $53 million.

With these high costs, it would be desirable to extend the navigation season on the Great Lakes to more than the current eight months. The U.S. Corps of Engineers has already demonstrated its ability to keep the Sault Ste. Marie locks open 10 to 12 months during the year. However, this extended navigation period has required the stepped-up replacement of some of the Coast Guard's obsolete ice breaking vessels, resulting in yet another expense.

Given the current limited navigation season on the Great Lakes, adequate stockpiling capacity should be incorporated into transshipment facilities. The underground feed-reclaim system developed for the Superior terminal is an excellent prototype for future storage and reclaim systems.

The need for modern, efficient transshipment facilities such as the one at Superior has already been alluded to. However, this again raises the cost factor. The Superior facility cost in the range of $45-50 million when it was built in 1976.

To achieve optimum operating efficiency in terms of invested capital, such a facility should ideally handle one large vessel per day. However, many potential western coal users will not have the need for 68,000 net tons of coal. Thus, the concept of multiple users should be explored and developed.

However, since 85 percent of the coal currently being burned is used by electric utilities, their demand requirements justify the development of a modern infrastructure for the distribution of coal. Once that infrastructure is in place, other small volume industrial and commercial customers should be able to make use of the distribution network and derive the economic advantages of unit train and super collier rates.

The capital investments outlined above are indeed significant and raise the question of whether an all-rail system would be more feasible. Although railroads will also play an important role in transporting the increasing volumes of coal, water transport via the Great Lakes will continue to provide an economic, as well as environmental, advantage.

First of all, the costs involved in upgrading and maintaining a rail system to haul the projected amount of coal could prove prohibitive. The railroads are expected to move about 799 million tons of coal in 1985. This projected coal movement would require a total capital investment of $6.1 billion. This estimate includes $2.4 billion for freight cars, $1.5 billion for locomotives and $2.2 billion for fixed plant additions and expansions. The country may not be able to afford the capital investment required to make an all-rail system work.

Secondly, the environmental and social costs, especially in the more populated areas east of the Mississippi, could be larger than the problems faced in using the Great Lakes where vessels move silently away from the metropolitan complexes and population. Thus, expanding the Great Lakes coal transportation system seems to be a very viable alternative.

Alaskan Oil and the Need for West Coast Oil Ports

Vital to the nation's energy goals will be the increased production of domestic oil resources. Although it is unlikely that domestic production can totally compensate for reduced imports, the potential does exist to increase production on Alaska's North Slope up to two million barrels per day. An important link in moving this oil from the North Slope to the existing pipeline system will be new deep water oil ports on the West Coast to accommodate the super tankers hauling the oil. There have been several proposals for oil ports in Washington State, in southern California and in Canada.

Kitimat

One proposal for transporting Alaskan oil into

the Northern Tier states of the U.S., was the recently withdrawn Kitimat proposal. This proposal would have required a deep water port on Canada's west coast at Kitimat. A pipeline would have been built to connect with existing pipeline systems at Edmonton. Oil from the Alberta oil fields is already being shipped into Minnesota from Edmonton on the Interprovincial pipeline. But with a drop in Canadian imports the extra capacity on this pipeline could be used to transport Alaskan oil.

Sohio

Another proposal, which has also been withdrawn, was the Sohio project. This proposal called for a new port at San Diego, California, and construction of a pipeline across the southern states into Texas where it would connect with the existing system.

Foothills

A third proposal, the Foothills or Skagway system, would bring the oil around the horn of Alaska and then follow the McKenzie River down to the Edmonton area refineries.

Trans Mountain

A fourth proposal, the Trans Mountain project, would come through Washington's Puget Sound up to the existing Trans Mountain pipeline which would be reversed to take crude up to the Edmonton area and then back into the Interprovincial pipeline. Under this proposal, Alaskan crude oil would be shipped into an expanded port facility in Washington State. Because the Marine Protection Act of 1977 was amended to prohibit any new tanker ports in Puget Sound, a modified Trans Mountain proposal with the construction of a new port at, or west of, Port Angeles, has been suggested.

Northern Tier

A fifth proposal, Northern Tier pipeline, would also require a new port facility at or near Port Angeles, Washington. From there, the crude oil would be transported through a pipeline to be constructed across the states of Washington, Wyoming, North Dakota and into Minnesota to connect with existing systems.

One of these proposals will probably be selected. At any rate, development of a West Coast oil port in the near future must be planned for. President Carter has pointed to the need to expedite the building of such a port in his recent messages on energy. To this end, he has suggested the creation of a new arm of the Federal Government to work through a number of often conflicting state, local and national regulations on the siting of such a facility.

Before production of Alaska's oil can be increased however, a way to use the gas that caps the oil deposits must be found. One way is to simply flare it, but such a method is obviously wasteful of precious energy resources. On the other hand, if a natural gas pipeline system such as the AlCan can be built, production of Alaskan petroleum can increase without flaring the gas.

President Carter has talked about strengthening cooperative efforts with Canada, specifically to bring natural gas from the North Slope through Canada on the AlCan system. The importance of such cooperative efforts cannot be overemphasized.

In conclusion, the subject of transporting energy materials by water raises a multitude of complex issues and problems, a few of which have been discussed here. To answer all the questions would involve a major study. It seems obvious, however, that the use of domestic oil and coal resources will, of necessity, increase; that water transportation of these resources will also increase significantly; and that if this nation is going to meet some of its energy goals, these increases must occur rapidly.

With the expanded use of any resource, there are problems--economic, environmental and social--that require conscientious and comprehensive solutions. An influx of capital will be needed to build the necessary facilities and to resolve the tough environmental, safety and security questions. Is the nation willing to invest the large sum of money that will be required? This question must be answered soon.

COMMENTS ON ELECTRIC TRANSMISSION ISSUES

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(NOTE: The statements presented here do not in any way reflect the opinions of any one other than the author.) This paper discusses the potential for using the nation's electrical transmission system as a transportation system for fuels. The advantages of transporting fuel by wire are economic benefits to the individual systems through fuel savings and possible deferral of new capacity and increased reliability through greater diversity of fuel sources for electric generation. There are obstacles to ready implementation of increased use of the electric transmission system. These include the lack of a pricing system for transmission rates and lack of assured paths of delivery. The change in the energy picture may require more rapid development of this area, and it offers sufficient promise so that it should not be overlooked.

The purpose of my discussion is to describe in an abbreviated fashion the existing electric transmission system and its potential as a transportation system for energy. The electric transmission system or grid that exists on a regional basis throughout the United States constitutes a transportation network for energy in the form of electricity. It is less often described as an alternate transportation network for fuels, but its uses in this context could significantly affect both transportation and energy policy. Two examples will illustrate my point. During the 1973-1974 Arab Oil Embargo, New England's electric supply was particularly affected because of its reliance on imported oil. Even if the United States had more than adequate domestic oil supplies, there would have been a delivery problem since the conventional transportation facilities were not in place to provide for a drastic switch in the source of New England's oil supply. One alternative selected to meet New England's need was the transmission of coal-generated electricity from the Midwest. This transmission was called coal-by-wire. The magnitude of these transactions was not great, for reasons that I shall elaborate on further in the text.

A second example to illustrate my point was the severe winter conditions experienced by the Midwest in 1977-78. At that time, coal piles stockpiled for electric generation froze and trains and barges were unable to deliver coal to the generating plants. At that time, nuclear and oil electric generation units from the East Coast delivered fuel by wire to the Midwest, in significantly larger quantities. You will note that both my examples relate to unusual situations, that is, an extraordinary situation called for unusual responses.

The issue I would like to probe is whether the grid that provides electricity on a fuel-by-wire basis in the unusual case can be used and called upon on a more regular, every-day basis in order to help our nation's energy situation. In my opinion, the benefits of being able to transact more fuel-by-wire arrangements are sufficiently attractive to warrant their serious consideration. For example, if fuel could be transported by wire, there would be a greater range of fuels available to individual electric systems. The advantage of diversity to any single electric system is evident. No single fuel source is immune today from potential disruption on a major scale, for example, nuclear plant shutdowns, strikes, or embargo. The advantage of diverse fuel sources is that a utility can obtain reliability without building a complete, back-up system for its current generation system.

There are also economic advantages to diversity. One potential savings that immediately comes to mind are savings in the cost of fuel. That is, if one region has lower cost fuel than another, then this information can be traded between regions to permit the higher cost regions to cut back on their production and utilize the lower cost fuel available from other regions in the form of delivered electricity. Other savings are available in terms of the size and number of electric generating plants that need to be considered. For example, if inter-regional transfers were available on a long-term, dependable basis, a utility or pool might decide to defer certain of its construction to take advantage of more economically-priced fuel elsewhere. Conversely, a utility that could take advantage of economies of scale if it had a larger demand might well advertise for a joint-participant in a unit far beyond its normal area, or if not joint participation, a sale of its excess capacity until its own system were able to absorb the full output of the plant. Yet another example is seasonal or peak-time diversity in which utilities take advantage of their differences in location to exchange energy economically.

All of the above considerations have impelled some utilities in some parts of the country to

engage in economy energy transfers, joint ownership and construction of plants, and seasonal exchanges of energy. However, there is a serious question whether enough utilities are engaging in enough of these transactions--and at the level most consistent with our national objectives. Moreover, the shortage of capital and the emphasis on conserving fuel and improving the use of our facilities would seem to call for some examination of why such fuel-by-wire transfers are not more frequent and massive and whether greater effort in this area should be made.

There are several factors that contribute to the relative paucity of fuel-by-wire transactions:

1. There are no rules presently to govern prices for these transactions. The rates are subject to Federal Energy Regulatory Commission (FERC) jurisdiction and are generally called conservation rates, although economy transactions is another term that encompasses some of these transactions. The FERC is presently involved in a rulemaking proceeding to establish rules for these transactions, but there does not appear to be any urgency in these proceedings. A key question, of course, is the amount of compensation to those utilities providing the electricity and the transmission service. For example, should costs be the criterion? a portion of the savings? or market price? In the 1973-74 Arab Embargo, the rates to the New England Pool for transmission services by the intermediate systems were so high that these sales were quickly terminated in favor of high-priced spot purchases of oil to be burned in New England's generating units.

2. The utilities resemble a collection of baronies of the medieval period in some respects. Each utility is responsible to its own set of regulators, constituencies, shareholders, and each operates within its own larger sphere of influence, e.g., its pool or with neighboring utilities. However, in the past, there has really been little attempt to foist national objectives onto the individual systems at the cost of their autonomy. Rather, local economies and technology have dictated movements towards coordination, and these have been relatively gradual shifts over a long period of time.

The fast pace of events relating to energy appear to have caught up with the system, however. The pressing need to use available resources now to alleviate everyone's fuel problems have spurred Congress to take a more affirmative step to make transfers of fuel--using the facilities of our nation's electric utilities--a reality. Specifically, I am referring to current legislative efforts authorizing the Secretary of the Department of Energy to order utilities to sell non-oil generated electricity to displace oil-generated electricity. The current bill sponsored by Senator Jackson is typical.

I think those in the transportation industry will have much to teach those of us in the electric utility field about the need for "through" rates to facilitate transfers. In most cases in the electric utility industry, rates through other systems must be negotiated on a system-by-system basis, and not one electron can flow until a contractual path is established between the supplier and the recipient. To make things more complicated, however, electrons don't behave like rail cars. Electrons wander over the system and--in light of the interconnected nature of the electric system--transactions between A, B, and C could affect D, a non-party to the contract. That is, while the contractual flow of power may be from A through B to C, the actual electrical flow of much of the power could be through D. Thus, I think you can appreciate the difficulty a system faces in attempting to secure an alternate source of fuel that requires transportation over many systems if each system had to be renegotiated.

New England has managed to avoid this transaction-by-transaction bargaining through the operation of a centrally dispatched pool called NEPOOL. Within the pool, I think it fair to say that economic transfers are made with assurance of deliveries over the many systems operating within the area. Such is not the case for the bulk of the United States, and that brings us to the question of how many more of these transactions can be facilitated. In this regard, I note that the state and local regulatory bodies, in some cases, have far more siting authorization than does the federal government. As to new electric generating plants and new transmission lines, there must be a balance struck between what the individual utility needs and encouraging more common use of those facilities for a larger constituency that may transcend local and state boundaries.

Key to the greater use of existing electric transmission facilities are the availability of transmission paths over the grid and the availability of reasonable rates, based on costs. Given these two elements, utilities and regulatory bodies could and would have available the necessary ingredients to evaluate fuel transfers on an economic basis. Likewise, competing fuel suppliers could judge the alternatives they could provide.

Even this brief discussion would not be complete without some mention of the environmental issues, both pro and con, that underlie any policy change. Obviously, the greater use of existing facilities in the manner I have described may present some environmental problems--but they might also present an opportunity to relieve environmental problems at a local level. Moreover, transfers of energy along the scale I have discussed may require modification of existing facilities, including greater interconnection capacity between the electric regions of this country. This is one area in which actual federal ownership of key interconnecting areas might be considered.

In any event, I think the possibilities presented by our existing facilities are exciting and present a more realistic option to modify our existing, oil-dependent electric systems into a more varied electric system. They also have the benefit of permitting the gradual shifting into diverse fuels for individual systems rather than requiring a major and possibly traumatic conversion, like building a nuclear plant to replace current oil facilities, for a single system. Since a transmission system is not reliant on a single fuel source, it has the quality of providing national fuel diversity and fuel accessibility to individual systems. In this way, the electric consumers will benefit from the lower bulk power costs while hopefully retaining the benefits of the high quality of service attributed to more locally-operated utility systems. I do not intend to suggest that the alternative presented in this discussion will solve the nation's energy problems, but I think it is too important to be overlooked as part of the solution.

ELECTRIC TRANSMISSION ISSUES - DISCUSSION

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The high voltage transmission system performs a number of functions and has distinct characteristics which are significantly different from the other energy transfer modes-i.e., rail, water transport and pipeline systems-being considered by the "DOE-DOT Joint Energy Sector Future Transportation Needs Study." These unique characteristics and functions include the following:

1. High voltage transmission lines operate as part of an electrical network and are, therefore, subject to physical laws applicable to electricity. The unique characteristics of electric energy transfers when compared to transportation of other energy commodities need to be clearly recognized in the study. These characteristics include: instantaneous generation, transmission and consumption of electric energy within the elements of the electrical network; the instantaneous effects of electrical faults (short circuits) on the network and the necessity for extremely rapid isolation and elimination of such faults; and the ability of the flow of power in a given line to change instantaneously its direction and/or magnitude, as system conditions dictate.

2. High voltage transmission lines interconnect adjacent utilities thus permitting exchange of electric power and energy between systems for economy and emergency support. These interconnections permit reductions in installed generating capacity and/or transmission facilities while maintaining the same overall reliability levels.

3. The higher-voltage lines (765 kV, 500 kV and 345 kV) operate in parallel with lower-voltage lines. If the higher-voltage lines were not used, additional lower-voltage transmission lines would be required to provide the necessary margins of system stability and reliability needed to withstand short-and long-duration faults, and facility outages.

4. A comparison of energy lost in transmission with that used in transportation shows: high voltage transmission lines use from .8% to 1.5% of the energy transmitter per 100 miles (160 km) depending upon the line loadings, unit trains from about .4% to .7% depending upon the grade of the rail line and operating conditions, pipelines about .5% and barges from .3% to .5%.

ENERGY TRANSPORTATION
Yesterday, Today and Tomorrow
Mario Cardullo, Acting Director, Office of Energy Transportation Policy, U.S. Department of Energy

Mr. Chairman, honored guests and fellow participants I appreciate this opportunity to appear before you today to present the Energy View of Energy Transportation. I have chosen for my theme Energy Transportation Yesterday, Today and Tomorrow. I believe in this manner we can focus in on the task that we face by viewing this important field in the perspective of time.

Yesterday

Under any free rational system, energy materials should follow a very simple rule and that is: move from their source to the nearest market maximizing their utilization before moving and being utilized in any other market. I believe this a simple consequence of the laws of thermodynamics-however-economists among you may feel otherwise. In any matter, the real economic, regulatory, environmental, technological world poses a series of constraints to this simple law.

Prior to DOE and the multiplicity of governmental and semi-governmental bodies, energy resources did indeed move in the most economic manner consistent with the technology available. The first movement of American petroleum took place in bottles. "American Rock Oil", as it was called, was skimmed from Appalachian pools and streams and sold as a remedy for all sorts of ailments - listening to the President July 15 it looks like the remedy has become the cause of the national ailment.

However, the movement of petroleum from the first producing wells near Titusville, Pa., was in barrels on horse-drawn wagons and in flat boats in the local creek. The railroad became the principal mode in 1862 when the first line was completed from the original oil fields. By 1875, however, pipeline technology had been developed which started to effectively compete with railroads -- it seems history does indeed repeat -- I only wish we wouldn't take so long to learn its lessons. The movement of petroleum by water in barrels on flatboats had also played a significant role in the early transportation scheme, but pipeline traffic eventually eclipsed that of river barges for the movement of crude.

However, all this took place in the much simpler national climate - one of national growth and expansion of unlimited social values.

The various components of the transportation system of the United States have played a vital role in the development and expansion of our energy industries.

Today

Where do we find ourselves today! As we all so painfully know - it is a changed world - one in which things are not as our forebearers knew them. Today we have many more technological tools available but also our social concerns have been raised. Today we face a world where it is not solely a question of how to move energy resources - but what energy resources to move. The Presidential policy we all heard July 15 I believe will help to focus our task - the task of the energy transportation planner to meet the goals that have now been set. I believe our goals today are:

1. Reducing the regulatory impediments for the movement of energy materials while minimizing the environmental risks.

2. Developing economical and energy efficient transportation systems for the increased movement of coal, synthetic fuels, domestic petroleum and natural gas which minimize environmental risks and damage.

To achieve these broad and general goals we should have as clear a policy framework as possible.

Coal

This country's future energy security depends in large part on its ability to rapidly expand the use of coal. This also implies the need for a well balanced transportation system to distribute this coal. Let me reflect briefly on the importance of coal to our national energy strategy. A key element of that strategy is to rely heavily on coal in the future. Recent DOE forecasts indicate that by 1990 this country will be using between 1.3 and 1.6 billion tons of coal per year for industrial and utility purposes. This alone is at least twice the coal production of 1977. To this now must be added the coal necessary for the critical synthetic fuels program the President has outlined. Expansion of our country's capacity to transport this increased amount of coal is essential. However, in developing the necessary transportation capacity, let us not erode coal's competitive advantages. It is therefore important that:

1. Coal users do not bear a disproportionate share of the cost of upgrading and maintaining railroads.

2. That any proposals for railroad deregulation emphasize protection for captive shippers such as utilities.

3. Passage of legislation to grant the right of eminent domain to coal slurry pipelines so that a framework is established within which the economic and public merits of any particular project can be debated and determined and ground rules for that determination provided. The feasibility and viability of many synthetic fuel plants will depend on the ability to provide large volume transportation of coal over long distances. Such conditions particularly favor coal slurry pipelines.

Petroleum

The goals set by the President will not only limit the amount of foreign imports but form the basis for requirements of the transportation systems. These goals also raise a number of yet unresolved questions.

In 1978, the United States was a net importer of 8,514,000 barrels (1,354,000 cubic meters) a day of petroleum consisting of 2,000,000 barrels (317,000 cubic meters) a day of refined petroleum products and 6,514,000 (1,037,000 cubic meters) barrels per day of crude oil. These imports are now planned to be substantially reduced by 1990. In light of these reductions it is important to review our existing petroleum transportation forecasts and plans.

The changes envisioned by the President's plan focus on the increased reliance on domestic production. This implies development of Alaskan frontier resources, such as the Beaufort Sea and increased North Slope production, increased California heavy oil production, and synthetic fuel based on coal and shale plus substantially reduced foreign imports. Thus we must assess the needs for expanded crude oil pipeline systems.

The existing domestic system of over 70,000 (112,630 km) miles of trunk pipelines and an equal number of gathering and product pipelines is now based upon a system which was configured to have access from the existing domestic fields and ports (for imported petroleum.) If the Presidential objectives are achieved then the system could literally take a different direction. That direction is a greater reliance on additional Alaskan energy resources

and also from the now declining Rocky Mountain region. The President's oil curb could also seriously impact the need and plans for superport developments on the Gulf and West Coasts.

It must be added that due to the reduced availability of foreign imports, the domestic supplies such as the Alaskan North Slope crude could achieve with refinery conversions a maximization of use on the U.S. West Coast. Many of the new domestic supplies such as the increased California and Alaskan production will be the heavier sour crudes, which will require refinery conversion. Refinery configurations coupled with transportation options will determine where these specialized crude oils will be processed.

It is therefore important that the proper planning have factored into it these changes in sources of supply. Similarly, it is important that the proper regulatory climate exist for these newer developments.

It is unacceptable that many important developments of the pipeline system have been delayed by the regulatory structure. It is hoped that the proposed Energy Mobilization Board can achieve a balance in reducing the permitting regulatory maze while maintaining the proper environmental balance. Further, the resolution of current Federal Energy Regulatory Commission dockets on pipeline rate making will also reduce the level of uncertainties.

Natural Gas

The new directions set by the President July 15 also place a larger reliance on the increased use of natural gas. This area of energy transportation requires an expeditious solution to the financing problems facing the Alaskan gas line. The President has made it an important point that this line be built as soon as possible. The availability of this line will not only provide an additional reduction of imports but will assist Alaskan crude oil production. The associated Alaskan North Slope Gas cannot be continued indefinitely to be re-injected; it must eventually be shipped. The existing developments in the Overthrust Belt in the Rocky Mountain area while not as costly as the Alaskan gas line are equally important. Here again the Energy Mobilization Board and its expected procedures could be of assistance coupled with an expeditious conclusion of the FERC rate process.

Nuclear and Electrical

Even though the area of nuclear material transportation and electrical transmission are not within my area of responsibility, I would like to briefly touch upon these important issues. In the area of nuclear waste transportation, I would like to say that DOE seeks to assure the continued development of environmentally secure systems. The DOE is working to develop its systems and regulations to this end.

The Department of Energy is engaged in a number of research and development programs seeking more efficient methods for its own marketing systems such as Bonneville and the other Power Administrations, and will continue to work to provide effective systems.

Tomorrow

I would like to relate some of the things the DOE, and in particular my office, are doing and will continue to do in the area of energy transportation:

1. National Energy Transportation Study - DOE and the DOT are conducting a joint study of the ability of the nation's transportation system to move the projected mix of energy supplies to their markets out to 1990. A report will be completed and hopefully released before the end of the calendar year.

2. Northern Tier Study - The office is in the final phases of completing and issuing the final version of draft report, Petroleum Supply Alternatives for the Northern Tier and Inland States Through the Year 2000.

3. Energy impacts of the Milwaukee Railroad Abandonment - The office has begun a preliminary study to determine the impacts on energy production, movement, and use in areas currently being served by the Chicago Milwaukee Railroad that we expected to be abandoned.

4. In the forthcoming FY we are planning to develop the framework for a National Energy Transportation Plan which will be tied to the National Energy Plan. This document will be a planning document with goals, forecasts, programs and plans. This project is in the early stages of development.

I would like now to relate to you, what I believe is one of our more exciting projects. It appeared to us that crude oil pipelines exist in several places in proximity to coal deposits. For example, crude oil flows through 3 lines, the Platee, Amoco and Arapahoe pipelines from Wyoming to the mid-continent refineries. The total crude oil flow out of Wyoming at present is about 200,000 barrels per day. It occurred to us that if ever a small amount of coal could be carried along with crude oil in these pipelines and successfully employed to enhance the net hydrocarbon output from the same amount of crude oil, the benefits could be significant. Some very preliminary studies that we have had undertaken on our behalf have indicated that a program to enhance the hydrocarbon supply of the Nation by the transportation of coal/crude oil slurries in existing pipelines and the integration of such a slurry system into modifications of existing refineries or into new conversion facilities could potentially be easier and more economical than coal liquification alone. Our very preliminary studies indicate it may be possible to incorporate up to 5% coal by weight using existing lines and pumps and modifying trays in distillation units. With pipeline modifications, and hydrotreated and other heavy oil facilities it may be possible to incorporate as much as 30% by weight coal, this translates to 20% more barrels per day of production. Hence, from technical, economical, and public policy viewpoints, such methods may offer better potential to enhance the supply of liquid hydrocarbon production than liquification. We are in the process of exploring this concept in deeper detail.

In closing, I would like to tell you a story: It seems that mankind likes to repeat its mistakes. In the early days of the Roman Empire, western society started to become highly dependent upon an eastern product - spices. These rare and wonderful substances made it possible for western society to tolerate and eat food that in many instances had started to spoil due to the lack of refrigeration. This dependence of spices and other rare substances grew even with the decline and fall of the Western Roman Empire. But then we had the rise of Mohammed.

With the spread of Mohammedism the vital caravan trade routes came under the control of the eastern powers -- this in turn led to increased cost and finally with the collapse of the Byzantine Empire a total monopoly was achieved which was assisted with the multinationals of the time -- the sea powers of Genoa and Venice. Only through searching for new routes did western society stumble upon new land -- the moral of this is that by seeking a better or new energy transportation system to reduce our dependence on foreign resources we may hopefully find a new energy future.

HIGHWAY TRANSPORT ISSUES, Henrik E. Stafseth American Association of State Highway and Transportation Officials.

The most important issue before Congress today is energy. We have been in a state of concern about energy that dates back before the oil embargo of 1973. At that time, the Administration encouraged the mining of coal and the development of other energy sources to substitute for the imported crude oil which we receive from the Near East that is subject to variation in its flow as different political courses develop in that area.

The President has just announced his latest energy program which contains a call for increased coal production. In the first proposal the President suggested establishing an energy security corporation to develop 2.5 million barrels of synthetic fuel from coal, oil shale, biomasses, and unconventional gases, by 1990. The second proposal is to require our private utility companies to cut oil consumption 50 percent which implies coal substitution. A third proposal, which is unrelated to coal, is to continue the exemption from federal fuel taxes for gasohol. This gives the member departments of the American Association of State Highway and Transportation Officials (AASHTO) deep concern. With more fuel efficient cars already causing revenue to drop, the exemption of gasohol would cause an additional loss of revenue creating a hardship to our member departments in maintaining roads. For example, in Iowa, the State Legislature has given a similar exemption for gasohol from its State fuel tax and they are experiencing a loss of a million dollars a month, or 20 percent of the annual revenue.

Maintenance needs have been increased by another problem that the States are facing as a result of the 1973-74 oil embargo. Congress in the 1974 Federal-aid Highway Act, raised the allowable load limit on Interstate highways from 73,280 pounds to 80,000 pounds.

It was recognized by AASHTO, through the results of the Ottawa Road Test, that such an increase would cause a reduction in pavement life of approximately 25 to 40 percent. Those States that changed their gross weight limit to 80,000 pounds have experienced the above estimated loss of life of the pavement. An increase in gross load of several thousand pounds has a dramatic effect on the States and local governments because the shortened life of the pavement can mean resurfacing, or in many cases, reconstruction of existing pavements.

It was reported by the Bureau of Mines that from the year 1950 to 1969, average pay loads for trucks increased from 10.3 tons to 28.5 tons.

A General Accounting Office report indicates a 22 percent violation rate in truck overweights on public highways. Hauling of basic materials, such as coal, is such a competitive business that in order to make a reasonable profit the independent truck owner competing for the haul of such materials is tempted to load his truck to as high a weight as possible without damaging the truck. Some private truck owners that do this type of hauling are very aware of the probability of being caught for violation on an overhaul and some of them haul overweight loads with the expectation of having to pay fines which will total less than the added revenue. If they have a bad experience where the enforcement is rigid and they receive citations more frequently than they anticipated by their statistical analysis, then they simply plead poverty to the courts and with the possibility of putting a breadwinner out of business, this makes for a difficult decision for our judiciary system.

The States that have experimented with higher fines, stricter enforcement, and all kinds of mechanisms have found that in many cases they have had little success.

The following are examples of types of problems that we have experienced in some of the coal-producing States:

There is a problem in Virginia that the highway department is experiencing in highway truck coal hauls that causes them concerns. The State of Virginia has allowed heavier truck weights in the coal areas on their state roads than in a similar terrain that does not have coal mining. In spite of this privilege, the coal haulers are hauling overloads and are breaking up the state roads in those areas. As a matter of fact, they drive down the right hand side of the road in the daytime and the left hand side in the night time so they break up both sides of the road as a result. Virginia has just passed a law that requires peak holes in the truck dump box which will allow an inspector to visually inspect if the truck is overloaded without having to weight the vehicle.

The State of Kentucky has had problems with coal hauling, one is that the coal trucks are delivering mine coal from Eastern Kentucky coal mines to Wisconsin by way of Louisville, Kentucky, which is an unreasonably long haul. Kentucky, in some cases, has had coal haulers or coal miners that are mindful of the importance of well maintained roads and have given financial assistance to the maintenance of these roads to the mutual benefit of the state and the coal producer. The people of Kentucky have also had coal producers that contribute nothing to the maintenance of the highway and have caused great damage to the public roads.

The energy related problem that Colorado faces is rather unique in that they are not a major coal producing State; however, being a hub of transportation they have long coal trains that are being hauled constantly across the State in certain areas. This has a very disruptive effect on the highway traffic that crosses at grade at railroad crossings.

We would like to call to the attention of this Conference that a study of highway needs to solve energy problems, called for in the Surface Transportation Act of 1976, Section 153, was delivered to Congress in August 1978, by the former Secretary of Transportation, Brock Adams. The goal of the study was to determine if special federal assistance is needed for the transportation of energy resources. The study viewed three areas - coal delivery, roads needed for hauling uranium and oil, and energy induced needs which covered the movement of workers, materials and equipment at energy facility sites. Examples of these sites are power

plants and refineries. Additional travel studied was the travel required for increased population to support new energy activities. The study findings for funding needed between now and 1985 were:

1. $7.3 billion, or 76 percent of the needs determined were to build or rebuild roads used for coal-hauling.
2. The cost to improve roads for hauling uranium and oil amounted to four percent, or $400 million.
3. $1.9 billion, or 20 percent was related to induced highway needs required because of the development of boom towns, power facilities, offshore drillings, and the need for rail/highway crossing improvements.

The needs study was contributed to by 27 States and 88 percent of the haul roads needs were in the Appalachian area. Eight percent of the energy-induced needs were West of the Mississippi. The study concluded that the needs were rather local in nature and would be difficult to fund out of existing highway programs.

There is some assistance for energy haul roads and existing programs and some of those are listed, as follows:

. The regular Federal-aid highway program, especially those roads on the Primary and Secondary Systems.

. Other highway programs which have received appropriations from Congress and which could be applied to coal road needs.

. The abandoned mine reclamation fund, in accordance with the priorities and procedures established in the law.

. The newly proposed energy impact assistance program ($150 million per year of grants, loans, and loan guarantees).

. Appalachian highway funds (the Appalachian Regional Commission and the Department of Transportation are initiating a study of the program, with one potential option being to allocate more funds to coal haul roads.)

The Administration has been thinking of a federal severance tax to approach this problem and, of course, many States use a severance tax to offset local obligations.

NATURAL GAS FLOWS IN THE MIDTERM: METHODS AND RESULTS FROM TERA'S NATURAL GAS NETWORK MODEL

Robert E. Brooks, TERA, Inc.

In June 1978, TERA, Inc. was awarded a contract by the U.S. Department of Energy, Office of Policy and Evaluation, to do a study of the National Energy Transportation System (NETS). This study was part of a larger effort sponsored by a joint task force consisting of the Departments of Energy (DOE) and Transportation (DOT) to identify potential bottlenecks in the U.S. energy transportation system in the period 1985 to 1995. TERA's role in this study was specified to be the development and implementation of a methodology to disaggregate national energy supply and demand scenarios provided by DOE for 1985, 1990, and 1995 into detailed supply and demand forecasts at the Bureau of Economic Analysis (BEA) regional level. In addition, TERA was to be responsible for the development and implementation of a rational methodology for estimating interregional flows of energy materials from each BEA producing region to each BEA consuming region in the country. The energy commodities included in the NETS study were coal, crude oil, refined oil products, and natural gas. This paper describes the results of that study in the area of natural gas.

Outline of NETS Study

Scenarios for the NETS study were produced by the DOE/MEFS model. This model, more precisely known as the Midterm Energy Forecasting System, is an outgrowth of the Project Independence Evaluation System, PIES. MEFS produces a simultaneous forecast of supplies, demands, and interregional flows for all energy commodities produced and/or consumed in the United States. The MEFS forecast is based on a complicated regional breakdown and is used as an input by the TERA NETS system. The regional breakdown, or level of disaggregation, for the NETS model is the BEA region. These 173 regions were used by BEA through 1978.

For each MEFS forecast, TERA's NETS system disaggregated that forecast into a more highly detailed forecast by BEA. This disaggregation is accomplished by analyzing historical production factors and economic variables which cause local variations in energy production and demand growth rates for subregions within the larger MEFS regions. These economic factors are used to forecast "shares" of production and demand for each of the subregions which, when applied to the DOE/MEFS forecast for the larger DOE regions, enable the model to compute forecasts of production and demand for each BEA.

In addition, since production and demand are not equal for each BEA, energy must be transported between BEA's to achieve a supply/demand balance. The TERA model computes a solution for such "origin-destination flows" using a cost-minimizing linear programming model of the energy transportation system. This solution is totally consistent with the higher level interregional flow data contained in the MEFS solution.

For natural gas, TERA used a BEA level model of the actual and planned natural gas transmission and distribution network in the U.S. based on the GASNET3 natural gas distribution system. This model uses the supply and demand forecast from the disaggregation step to calculate the minimum cost gas transmission pattern which best utilizes existing and planned gas pipeline capacity. In locations where capacity is not sufficient, the model permits and simulates construction of new pipeline capacity. The TERA model also identifies pipeline paths in the network which may be seriously underutilized in the forecast period.

Development of Data Set to Run Model

Production Shares

In the NETS natural gas methodology, "production shares" for forecast periods were estimated to be functions of historical production and reserve estimates. A production share is that share of each DOE gas producing region which is produced by each county in that region. BEA production was estimated as the sum of all production in counties within that BEA.

Demand Shares

In the DOE/MEFS model, natural gas demand was computed for four different end-use sectors for each gas demand region. The four sectors were residential, commercial, industrial, and electric utility. The approach taken by TERA in disaggregating MEFS

demand to 173 BEA regions involved estimating demand in these four sectors for essentially every supplier of gas in the country identifying the BEA in which each of these suppliers operated, allocating that demand to that BEA, and finally summing up all such demands for each BEA.

This data enabled an estimate to be made of the shares of regional consumption for each BEA for the base year 1976. Further growth data were needed to estimate shares for 1985, 1990, and 1995. In the TERA natural gas disaggregation model two growth variables were used: population for residential consumption; retail and wholesale trade for commercial consumption. It was assumed that demand would not be growing for the industrial and electric utility sectors and the 1976 shares for each subregion for these two sectors were used.

Network Structure

The NETS natural gas flows model was formulated as a network, a structure consisting of nodes and arcs. Nodes represented either locations or areas in the system and arcs represented the transportation paths between those locations or areas. A network can be graphically represented as a set of circles (nodes) connected by arrows (arcs) pointing from each origin to each destination in the network.

The gas network model used for NETS was based upon currently existing and planned natural gas pipelines in the U.S. Each of these pipelines was modeled as a subnetwork of nodes (representing BEA's) and arcs (representing physical pipelines connecting contiguous BEA's). The NETS model consisted of an aggregation of these pipeline networks. All pipelines delivering gas between the same origin and destination were combined into a single arc in the model. The model included essentially all existing inter and intrastate gas transmission companies which cross BEA boundaries, distributors which crossed such boundaries, and planned pipeline systems.

In order to compute a forecast of flows along the arcs of the NETS model, the following information was needed:

1. supplies and demands for each node
2. capacities of pipelines
3. efficiencies of transporting gas
4. cost of transporting gas.

With this data, and using a special type of linear programming known as a "generalized network" or "network with losses," a set of flows was found which satisfied all demands with the existing supplies, which satisfied the capacity and efficiency constraints, and which minimized the total cost of transportation over the entire network.

Estimating Pipeline Capacity

For most pipeline arcs in this model, Federal Energy Regulatory Commission (FERC) Form 2 reports of the pipeline companies which contained sections on compressor station capacities were used. A regression model of the relationship between pipe sizes and capacities was used to estimate the capacity of arcs where compressor data was not available. Data about pipe diameters "downstream" from compressor stations were obtained from the Federal Power Commission's 1974 map of interstate gas pipelines.

Estimation of Arc Efficiencies

Efficiencies were estimated for each node in the gas transmission network. An engineering definition of efficiency was used (ie. the ratio of gas out to gas in, or the fraction not lost, unaccounted for, or used to run compressors). Node efficiencies were converted to arc efficiencies by using the efficiency of the destination BEA. This method implied that gas flowing from the origin BEA is used or lost in the destination BEA. Thus, pipeline capacity on the arc constrained the amount leaving the origin before losses, not the amount leaving after losses as would have been the case if the efficiency of the arc was assumed to be the efficiency of the origin node.

Pipeline Transmission Costs

Estimates of the cost of shipping gas through the natural gas pipeline system were derived with regression analysis using transmission data for various companies. Transmission data from FERC's Form 2 reports included revenue, distance, and the amount of gas transported by the reporting companies for other pipeline companies.

The cost of shipping gas was shown to be directly proportional to the quantity of gas shipped and inversely proportional to the capacity of the pipeline involved. This is consistent with the fact that gas compressors burn natural gas in the process of moving it through the pipelines and consequently shipping costs would be proportional to distance. Also, large compressor stations are relatively more cost efficient than smaller ones, thus decreasing the costs of larger capacity pipelines.

Aggregating Capacity, Efficiency, and Cost Data

The model was aggregated as follows:

1. Pipeline capacities for companies operating over the same BEA origin to destination arcs were summed to yield overall capacities.
2. Mileages were weighted according to pipeline capacities and then averaged.
3. Costs were weighted according to pipeline capacities and then averaged.
4. Since regional efficiency factors were computed for each BEA region rather than for each company, they were used directly without the need for averaging.

The result of this aggregation process was a data set consisting of the following data and estimates for each arc:

1. Region of origin
2. Destination region
3. Arc capacity in MMCF/year
4. Arc mileage
5. Arc efficiency factor
6. Arc transmission cost in cents/MCF.

Results and Conclusions

In October 1978 TERA completed the first two NETS scenarios and they served the purpose of testing the preliminary NETS methodology. In April, May, and June 1979 TERA received from DOE the five final scenarios to be used for the NETS study. They were:

1. C-Medium 1985
2. C-Medium 1990
3. C-Medium 1995
4. E-High 1990

5. C-Low 1990

The three C-Medium cases were conservative estimates for supplies and prices for 1985-95 while the E-High case was a pessimistic view and C-Low a cautiously optimistic view for 1990.

Natural Gas Results

For the purpose of identifying potential bottlenecks in the energy transportation system, TERA developed a model of the gas transportation system which would allow for construction of new facilities in addition to those already in place or planned and approved. TERA identified a number of places where new construction was likely to be needed. What follows will concentrate on the three C-Medium cases since the other two were very similar to the 1990 C-Medium case.

In the 1985 C-Medium scenario there were twelve pipelines in the domestic network which appeared to need more capacity. Of these twelve one was very marginal (only 1% additional needed) and two others needed less than 20% extra capacity. The remaining nine lines needed from 43 to 137% extra capacity. In terms of greatest potential problems it appeared that the intrastate movements in West Texas, the movement from Northern Louisiana to Arkansas and the movement from New York to Connecticut were the important ones to consider. Additional "local" difficulties in South Carolina, Georgia, Tennessee, and Alabama were also identified. Minor problems in Arkansas and Southern California were also noted. In general the existing pipeline network and planned additions seemed to account quite well for most of the flows forecast by the NETS model for 1985. The few problems foreseen were mostly due to increasing population and economic growth in the Southeast. The West Texas bottleneck could be due to increased Eastern demand for West Texas gas with few existing links to satisfy it. The increased demand for capacity from Louisiana to Arkansas could reflect a deteriorating Arkansas gas production picture.

In the 1990 case many more lines were predicted to need additional capacity and all bottlenecks for 1985 appeared except the one in the Northeast. This was because the MEFS model assumed that the TAPCO LNG (liquified natural gas) project would be online by 1990 (but not 1985) bringing gas south from Canada and Maine into New England and New York. Thus, there would be less demand for gas in Connecticut in 1990 from Southern sources. New bottlenecks appeared in the north central states of North Dakota, South Dakota, Minnesota, Wisconsin, and Iowa. This principally involved two large companies: Northern Natural and Northern Border. Additional capacity was predicted for Northern Natural to serve Northern Minnesota and Wisconsin customers, possibly due to population and economic growth factors. There also seemed to be additional demand on the Northern Border pipeline to transport gas produced in Montana and North Dakota to the upper Midwest. Northern Border was principally designed to transport gas from Alaska to the Midwest. The NETS model saw it as the best route for increasing quantities of gas produced in Northern Tier to get to Midwestern markets. Assuming Northern Border agreed to increase its capacity to transport this gas, this would also likely result in additional capacity for Montana-Dakota utilities to transport the gas from Montana to the Northern Border pipeline. Additional capacity needs were also predicted for Western Slope Gas to transport more gas from the San Juan Basin producing area to users in Eastern Colorado. Finally a small additional capacity may be needed by Southwest Gas Company due to increased demands in Southern Nevada.

In the 1995 C-Medium scenario major shifts in gas supply resulted in substantial alterations in distribution. From 1990 to 1995 the C-Medium MEFS scenario showed a dramatic drop in interstate deliveries, a large increase in SNG (synthetic natural gas) production, a major decrease in Canadian imports, and correspondingly large increases in LNG imports. These changes resulted in a substantially greater demand for Midcontinent and Rocky Mountain gas in the Midwest, increased demand for Alaskan gas by California, a major decline in gas deliveries from the Gulf Coast to the Northeast, and increased reliance on LNG and "local" SNG supplies. The list was substantially longer than in the 1990 case and included all but four of the lines in the 1990 list. The main locations of new capacity requirements were the Midcontinent corridor (Natural Gas Pipeline of America, Northern Natural, Michigan, Wisconsin) and Texas.

Table 1 (Source: TERA, Inc.) below shows examples of companies having need of greater capacity, and the associated capacity and maximum expected flow of their pipeline systems (both in MMCF/year), as forecasted by the TERA NETS model. C-Medium cases only were selected.

Table 1. Companies needing more capacity (1985).

Pipeline Company	BEA Region Orig.	BEA Region Dest.	Capacity	Maximum Expected Flow
Carolina Pipeline	26	29	21,042	37,876
" "	28	29	7,823	14,081
S. Georgia Nat. Gas	43	41	21,042	48,234
Southern Nat. Gas	44	42	68,889	124,000
" " "	44	48	21,480	38,664
E. Tenn. Nat. Gas	47	48	13,657	26,605
Lo Vaca, Intratex, Delhi	124	126	335,280	603,504

Conclusions of the Study

The two most substantial changes in the model were caused by the reduction of gas imports from Canada. As a result, gas demand in the Midwest must be met from supplies in the Midcontinent area. Substantial capacity increases of as much as 145% from the Texas Panhandle to the Great Lakes will be needed to meet this demand. California may become totally cut off from its traditional Permian supplies since gas from the Permian Basin will be needed in the Midwest. Thus, California will additionally rely on Alaskan gas from both pipeline and LNG tanker.

In summation, from the present to 1995 there appeared to be a clear trend away from traditional sources and delivery systems from the Permian Basin and Gulf Coast toward greater utilization and growth in the Rocky Mountains, Midcontinent, and Northern Tier, as well as increased reliance on Alaskan gas, locally produced SNG, and foreign LNG. However, 1995 is a long time away and many assumptions necessary to run the MEFS model were speculative at best. Significant changes in these assumptions could well result in significant alterations in the more detailed NETS model. Also, due to the dynamic nature of the energy system of the 1970's and 80's, several major policy changes have been made recently. These include the denial of two major LNG projects (TAPCO in New England and El Paso II on the Gulf Coast) and the abandonment of the SOHIO pipeline project. These decisions will have a major impact on natural gas transportation patterns in the midterm.

THE ROLE OF THE OIL PIPELINE INDUSTRY IN TODAY'S ENERGY ENVIRONMENT

Keith E. Bailey, Williams Pipe Line Company

This paper discusses the two major areas impacting the oil pipeline industry today and develops potential scenarios for the future of the industry.

I appreciate the opportunity to meet with this group and discuss the role of the oil pipeline industry in today's energy environment. Had this presentation been made 10 years ago, it would have been very easy to prepare and equally easy to do justice to the pipeline industry's role in the time allotted in tonight's program. I simply would have discussed the oil pipeline industry's history of steady growth and high operating efficiency and its excellent safety and environmental record, provided appropriate statistics, and compared those to the three other surface transport modes. Then I would have closed by saying the obvious: namely that the oil pipeline industry is a vital transportation link in our nation's energy systems and has served the country well.

I can still say all of those things and make those comparisons but to do so would take time away from, what I view as the critical issues facing our industry today. I hope you will accept as a matter of fact all of those items I enumerated and if there is time available for questions later, I would be happy to furnish data to support those statements.

What I will spend my time on this evening are the areas of government involvement in the oil pipeline business, the current energy supply/demand outlook, and the potential impact of these areas on the economic health of our industry. I feel that in both areas choices are available and the range of potential results is from a continuation of a healthy industry to that of an industry which is so financially and structurally weakened as to chill future investment which in turn would force the nation to other less effective transportation modes.

Government involvement in the energy industry has increased dramatically over the last decade and at an ever accelerating rate. This activity has been in a multitude of areas including construction permitting, environment, safety, personnel, operations, rate making, and even ownership. While all of these areas can materially affect the industry, I will focus my remarks on the last two: rate making and ownership.

Since early in this century, the oil pipeline industry has been regulated with regard to its rates and its operating practices insofar as they relate to its shippers access to and use of its lines. This regulation was administered by the Interstate Commerce Commission until October of 1977 and has been administered by the Federal Energy Regulatory Commission since that time. The regulatory approach used by the Interstate Commerce Commission was generally one of only monitoring companies activities through the means of their annual report Form P's. It was only where shipper protests were involved as a result of a specific pipeline's tariff action that the ICC instituted formal hearings.

The industry was aware of the earnings guidelines it was subject to as a result of two landmark ICC cases and a 1941 consent decree with the Justice Department. One major attribute of the historic method of regulation was that the fair value style of regulation used by the ICC allowed rate of return standards established in the 1930's and 1940's to remain reasonably compensatory over time since automatic adjustments in the rate base reflected in large part the inflationary pressures felt by the industry. At the time the FERC was established and assumed the ICC's former authority over oil pipelines, my company, Williams Pipe Line, along with Explorer Pipeline, had a rate case pending on appeal before the Federal District Court in Washington, D.C. This was a case which had been resolved in an administratively final manner by the ICC using its traditional guidelines. This administrative decision had been appealed to the judicial branch by the small group of shippers who had protested Williams tariff increases and who also had advocated changes in the historic ICC method of regulation. Although the ICC supported its decision before the court, the FERC asked that the case be remanded in order that the FERC could establish its own style of regulation. Even though the proceeding already encompassed a time period beginning in 1971, the Court honored the FERC's request and remanded the case in early 1978. This has now become what appears to be the landmark case which will determine the FERC's method of regulation for the oil pipeline industry. Phase I, which is proceeding currently, will establish comprehensive general rate making principles. Because the FERC staff is primarily composed of former FPC employees, it has adopted a position on rate making which is the same as it has historically used on gas pipelines. It is a net original cost

rate base approach. This, combined with staff attitude which seems to be very negative with regard to the industry and its former regulator, means the industry faces some trying and potentially damaging times in the near future. Hopefully, the general rate making procedures will be developed on a factual basis and not an emotional one. It is obvious the financial viability of a critical industry is at stake.

The second area of government activity which I said I would discuss is that of ownership of oil pipelines. For several years there have been various administrative and legislative assaults on the ownership of oil pipelines by vertically integrated oil companies. The substantial majority of existing pipelines have just such an ownership. While the Justice Department and some members of Congress have been advocates of divestiture in the past, the banner is currently being carried by the FTC. The FTC has asked for public comments and appears to be moving forward on a thesis which presumes divestiture is warranted. The issues here are whether or not ownership of oil pipelines gives "shipper-owners" unfair advantages in the marketplace through either unreasonably high pipelines earnings or by control of access to those markets. The proponents of divestiture have proposed several theories to support their position but have presented no facts to support those theories. Once again, choices are available to us and once again they must be made on a factual and not an emotional basis. It would come as no surprise if I said our nation's energy supply is becoming increasingly tenuous. As the supply of petroleum is limited to the point that it equals or surpasses demand the elasticity is removed from the logistics system. The refining capacity in this country is concentrated in a limited geographic area and in turn serves a broad geographic area. This obviously requires an extensive distribution network which, for the most part, consists of pipelines. The logical question one might ask regarding the existing pipeline network is why should the tightening of supplies have any impact. The answer is fairly simple. Historic supplies have allowed sufficient inventories to be carried in the ultimate distribution areas to allow pipeline capacity to be designed at essentially average annual throughput rates with the storage accommodating the winter demand peaks for middle distillates and the summer demand peaks for gasolines. Because of the broad geographic areas served by our refining centers they must concentrate an increasing percentage of the inventory at the refinery origin as the overall inventory levels decline. In effect the pipelines are being asked to accommodate current demand on a current basis. In many cases this requires capacity increases and much wider fluctuations in month to month capacity demands.

Without question, the level of general business uncertainty in the energy area is as high as it has been in the modern history of our country. With in excess of 50% of our petroleum needs being supplied by foreign countries over which we have no control and, in many cases, little influence, the supply picture is very unclear. With nothing other than these fundamental supply/demand questions to be faced, it is obvious the oil pipeline business would be faced with making investment and operating decisions in an even higher risk environment than has been the case for the past 30 years.

Now we move to the point which I feel is the crux of the issues I just outlined. What is the current impact of these issues and what is the range of future impacts on the industry.

When you superimpose the unanswered questions of, What is my real earnings potential even assuming I realize the volume of traffic I anticipate? and Will I be able to retain ownership of this property even if I make the investment? On the substantially increased levels of normal business risk growing out of the uncertain supply situation the impact on the industry is predictable. Investments will be minimized, if made at all, and even those that are made may require business needs external to the basic transportation system to support them.

The question I pose to this group today is, At this critical point in our country's history can we afford to chill an industry that plays such a vital role in helping meet our nation's critical energy needs? It seems to me the answer is no. This is an industry with a proud history of innovation and one which I am confident can rise to meet our nation's needs if it is allowed to do so. But it is also one whose very roots are being threatened. The time to make the choice is now.

A COAL SLURRY PIPELINE

G. L. Maciula, Florida Gas Company

Twenty years ago Florida Gas began the transportation of natural gas to Florida and remains today as the only major gas transmission company supplying Florida. One of the major factors justifying the construction of the Florida Gas system was the availability of a plentiful supply of cheap natural gas which could be supplied to the Florida electric utilities as well as to industry and for domestic use. Another key factor that made the Florida Gas system possible was the contractual commitments from the electric utilities to transport their gas needs over long periods of time. The pipeline system was expanded over its first ten years as the demand for natural gas grew.

In the early 1970's the demand for natural gas began to exceed the new discoveries of natural gas. Studies made in 1974 of the future supply of natural gas convinced Florida Gas that one of its parallel pipelines from Louisiana to Florida would not be required for natural gas service upon the expiration of some of the original transportation contracts. Florida Gas proposed to convert a 24-inch (610 mm) line into a petroleum products pipeline to bring up to 350,000 barrels (55,700 cubic meters) per day of gasoline, jet fuel, and heating oil to Florida. The Federal Energy Regulatory Commission has yet to approve this project. However, approval is expected in the near future.

As most of you know, the evolving energy policy of the Federal government over the past several years indicates that the use of natural gas under boilers is an inferior use and compels the utilities to switch to other fuels. The oil embargo of 1973 and the present proposed restrictions limiting the amount of imported oil have increased and will accelerate the interest of the electric utilities in the use of coal for future plants. The cost, delays in permitting, and perceived danger of nuclear plants have also increased the appeal of coal as the fuel preferred for most future electric power plants.

With Florida Gas' history and experience in energy transportation, and the obvious need for radical solutions to our energy problems, Florida Gas decided to study the feasibility of supplying the transportation of the future coal requirements of the Florida utilities by the construction of a coal slurry pipeline. Since the likely sources of

coal are in Illinois, Indiana, Kentucky, and West Virginia, it was obvious that the route of a coal slurry pipeline to Florida would cross Georgia. Florida Gas, therefore, contacted utilities in both Florida and Georgia to determine their coal requirements and their possible interest in coal slurry pipeline.

Six utility companies joined with Florida Gas in a study of alternate systems. Bechtel was retained to perform the study. The study was finished last November. It clearly demonstrates that the project was economically viable and would save billions of dollars for the electric customers in Florida and Georgia.

A system that could ultimately deliver up to 55 million tons (50 million metric tons) per year to the six utilities was developed in the study. For comparison, it would require 42 miles (68 km) of trains per day to handle a like amount of coal. The system would be as much as 1,500 miles (2414 km) long and cost up to $3 billion.

Transportation of coal by pipeline is not a new technology. The Consolidation coal line started up in 1957. This pipeline which ran from Cadiz to Cleveland, Ohio was 108 miles (174 km) long, 10 inches (254 mm) in diameter, and had a capacity of 1.3 million tons (1.2 million meter tons) per year. It was mothballed when the railroads offered to reduce rates drastically on all 5 million tons (45 million metric tons) of coal transported from this district of Ohio. The Black Mesa pipeline began operations in 1970 and is still in operation. This pipeline in Arizona is 273 miles (439 km) long, 18 inches (457 mm) in diameter and has a capacity of 4.8 million tons (4.4 million metric tons) of coal per year. Other groups are studying coal slurry lines also. Some of these are:

	Miles (Km)	Million tons/yr (metric)
Wytex (Montana-Houston)	1,260(2,027)	22(20.0)
ETSI (Wyoming-Arkansas/ Louisiana)	1,378(2,217)	25(22.7)
Houston Natural Gas Co. Colorado-Houston)	900(1,448)	15(13.6)
Northwest Pipeline Corp. (Wyoming-Oregon)	1,100(1,770)	10(9.1)
Nevada Power Company (Utah-Nevada)	183(294)	12(10.9)

Other commodities that have been successfully transported in water slurries include ore concentrates, limestone, gilsonite, and phosphate.

While this paper is not intended as a technical paper, a brief review of the operations may be useful. In a typical coal slurry pipeline 2" x 0 (51 mm x 0) coal is supplied to the coal preparation plant where it is pulverized and mixed with water.The mixture consists of approximately 50% coal by weight of water. The slurry awaiting transportation is stored in agitated tanks. Perhaps the most critical aspect of coal slurry pipeline operations is the proper grinding of the coal and accurate blending with the required amount of water.

The slurry is pumped through the pipeline by piston-type pumps usually driven by electric motors. Inhibitors are added to the slurry as required to control internal corrosion. The pipeline itself is constructed in much the same manner as an oil or gas pipeline. It is externally coated and cathodically protected to resist external corrosion. An allowance is made in the wall thickness for anticipated erosion rates to provide a design life of 40 years or more.

At the termination point of the pipeline, the slurry is again placed in agitated storage tanks. Dewatering is accomplished by heating the slurry and passing it through a series of centrifuges and driers. The dried coal is then either stockpiled or fed directly to grinders for feed to the boilers.

While the final configuration and size of the Florida Gas system is yet to be resolved, we are convinced that very favorable economics and proven technology for this system exist. The essential elements of a large quantity of coal over a long haul over a long period of time are present. The problems remaining relate to

1. Right-of-way and permits
2. Water supply and disposal
3. Project timing
4. Project financing

1) There is, of course, strong opposition from the railroads to the construction of coal slurry pipelines. Obviously, the railroads would prefer to keep their virtual monopoly on overland coal transportation. Building a cross-country pipeline without the right of eminent domain to force permission for railroad crossings would be very difficult. Crude oil, petroleum products, and gas pipelines have the right of eminent domain in most States. Coal pipelines enjoy this right in only a few States - West Virginia, North Carolina, Ohio, Utah, North Dakota, Louisiana, Texas, Oklahoma, and as of a few weeks ago -- Florida. The other States the proposed system would cross have not enacted any such legislation.

In 1978 Congress considered but defeated a bill granting coal slurry pipelines the right of eminent domain. It appears the primary reasons for the bill's defeat were the concern for water use in the arid western States and a concern over the economic welfare of the railroads if coal slurry lines were permitted to compete freely with them. The bill was, of course, opposed by the railroads and some environmentalists.

In 1979 a strong continuing interest in eminent domain legislation is present in the current Congress. In spite of differences in opinion on certain provisions, such as a commodities clause, it is hoped that such a bill will be passed in this session.

Faced with a growing energy supply and cost problem, it will be a tragedy for the nation to deny the benefits of coal slurry pipelines to an energy hungry society for the lack of rights now enjoyed by the railroads and other types of pipelines.

2) As noted earlier, the water required to transport coal in a slurry is approximately equal to the weight of the coal -- one ton of water for one ton of coal.

The project envisioned would require a maximum of 44 cubic feet (1.2 cubic meters) of water per second. For comparison, the Ohio River has an average flow of 77,000 cubic feet (2,180 cubic meters) per second and appears to be a logical water source. It is believed that water resource studies

will show that the resources are sufficiently adequate so that it should not be the sensitive issue it is in the western states.

Disposal of the water after separation from the coal must also be carefully considered. Where the water can be used as cooling tower make-up, it would represent only 10-15% of the cooling water requirements. In these cases, the water disposal presents no problems. Where the plants use once-through cooling and, therefore, cannot use the slurry water, it will need to be treated and disposed of in ways acceptable to the water quality agencies.

3) The timing of the project is another critical consideration. Coal slurry pipelines can only operate in a fairly narrow range of throughput rates. The reason for this limitation is that the flow velocity must be maintained in the range of approximately four to six feet (1.2 to 1.8 meters) per second. Lower rates permit the coal particles to drop out resulting in capacity restriction or even plugging the line. Higher rates cause undue erosion. It is believed that the coal requirements for a system in the range of 30 to 40 million tons (27-36 million metric tons) per year will be feasible to commence operation in 1986.

4) The proposed system in today's dollars would cost in excess of $2 billion and with today's inflation, could run as high as $3 billion by 1986. In order to finance a project of this size, large, long-term commitments will be required from users of the system -- the electric utilities. Preliminary studies indicate that initially the cost of transportation of coal in a slurry pipeline will be equal to or slightly better than the prevailing railroad tariffs. However, in an inflationary economy, over the life of the project considerable transportation savings could be realized. The reason for these savings is that pipelines are capital intensive with only a small part of their costs subject to inflation. Railroads are labor intensive with a large part of their costs escalating with inflation. This being the case, the shippers should be willing to contract for long-term transportation, permitting the project to be financed.

Another important issue is the environmental impact of coal slurry lines. The Congressional Office of Technology Assessment has said "... the environmental issues amount to a choice between the water use and temporary construction impacts of slurry pipelines or the noise, land use, disruption, railroad crossing accidents, and inconvenience of increased train traffic. All other impacts are relatively insignificant or roughly equivalent for both modes...." It is hard to visualize any formidable environmental hurdles for the coal slurry pipeline.

President Carter in his July 15 energy speech emphasized conservation of energy and use of America's own energy resources including coal. The present annual production of coal in the U.S. is about 670 million tons (608 million metric tons). The railroads transport about 65% of that coal. The government has indicated coal production should be increased to 1.2 billion tons (1.1 billion metric tons) by 1990. If all of the coal slurry lines proposed for this time frame were built, they would carry only 150-200 million tons (136-181 million metric tons) of coal per year. These pipelines, then, will not replace the railroads but merely help provide the huge capital requirements needed to transport the coal the nation will need.

The pipeline will be built, it has too many savings for electric customers to overlook. The only question is when, considering the work remaining to be done.

COAL-OIL SLURRY PIPELINES: AN OLD IDEA IN NEED OF NEW RESEARCH

Michael J. Kendrick, Senior Economist, Transportation and Economic Research Associates (TERA), Incorporated

This paper presents brief comments on the concept, background and need for further research on slurry pipelines of coal in crude oil suspensions. A prima facie justification for this approach to coal shipment is presented along with a list of research needs.

I am pleased to be able to put before this Conference on Transportation of Energy Materials an idea well worth consideration. Shipping coal in slurries of crude oil is not a new idea but one which has sat on the shelf for a long time due to lack of opportunity. In keeping with TRB's mission to highlight areas of needed research let us dust this one off and examine its potential.

It was good to hear Mr. Mario Cardulo highlight the idea at his luncheon address. Since the area is one which requires a great deal of research and since our main purpose is fulfilled in getting the idea out and on the minds of researchers, little needs to be added to what Mario has already said.

I will add that little now.

Specifically, coal-oil slurry is a sort of ride sharing concept in the energy transportation area. In order to ship a solid like coal in a pipeline it must be finely crushed and suspended in a fluid. Water is the medium usually mentioned. Others have suggested methanol, even air. Reasons for using crude oil as a carrier are persuasive on the face of it:

- First, water resources in many coal producing areas, particularly the West, are in short supply. This is especially so due to the need for water generated by increased mining activity already associated with the coal industry.
- Second, existing pipeline capacity may be used, with no displacement of oil, in several instances where the coal and the oil share the same general movement. Incidentally, the lack of coincidences in movement is the prime reason why this idea is now touted as new. The Canadians in Alberta studied the concept back in the Fifties and found it technically feasible at a preliminary level, but dropped it because oil and coal did not move together at distances or volumes great enough to warrant any further study.
- Third, the economics of pipelines, already favorably assessed for coal-water slurries under the proper conditions (concentrated supplies and demands for large volumes) are further enhanced when the pipe is required to move nothing except payload. Pipelines are the only mode of transport which apply energy only to the movement of payload and not to the movement of carrying equipment. Even with this advantage the energy efficiency of pipelines, on the average, is not as good per ton-mile as water or rail modes. Therefore, if an inert carrying medium must also be pumped, much efficiency is lost. In a coal-water pipeline with 50 percent concentration of coal by weight, the pipeline is, in a sense, moving also a tare weight of 50 percent. This is very high by the standards of other modes. In a coal-oil pipeline the "tare weight" is zero.
- Finally, many of the arguments for slurry pipelines in general also apply. These include very low noise, visual and traffic interruption impacts; steadiness of service in all kinds of weather; and a low susceptibility to strikes or other interruptions.

Whatever the value of these arguments, much research is needed to make the concept a reality. Specifically:

- Technical and experimental work needs to be done to determine the engineering coefficients necessary for a thorough economic evaluation of the idea.
- A survey of the logistical possibilities is required. Mr. Cardulo already mentioned a few. A Northern tier type pipeline for Alaskan crude with coal interjection on route is another.
- Refining and/or separation technologies must be outlined and experimented with.
- The chemical characteristics of the delivered product must be determined and assessed for marketability.
- Finally, regulatory jurisdiction, right of way privileges and other legal questions must be addressed - they cannot be resolved by research.

SYNTHETIC FUELS

Edward J. Bentz, Jr., Executive Director of the National Alcohol Fuels Commission

Good Morning Ladies and Gentlemen. I am pleased to have the opportunity to be here and to share with you some of the findings of the recent studies on energy and particularly on synthetic fuels that have been conducted by the National Transportation Policy Study Commission, for which I served directing the Energy, Economic, Technology and Coal studies. What I'd like to do today is to very briefly describe some of the key findings in synthetic fuels, especially those that affect transportation. Because the NTPSC Final Report has been recently released and also because many of the underlying technical documents will be released shortly, I will try to keep my comments to brief findings and leave the technical back-up to the Final Report. Before I start, I would like to welcome the opportunity to thank the Transportation Research Board for having this opportunity and to the Conference Chairman, Edward Margolin, for receiving this invitation and for having the opportunity to be before you today.

There are two overriding themes that dominate the role of transportation of synthetic fuels, or more correctly energy and transportation. They are, one, energy and transportation play a dual role, that is to say, energy provides transportation needs for propulsion power, and the second portion of this dual role is that fuels and energy in general need transportation so that supply regions may be connected to demand regions. Especially for the newer synthetics, this is a crucial point since they must be developed and brought to the existing demand regions. The second major overriding point is that our energy problem or energy crisis or energy concerns will not be solved by one solution but by a multiplicity of many solutions, of which synthetics do occupy a role, but not the only role.

In addition to the two overriding themes addressed above, there are two key symptoms that characterize transportation today and in the near future. One, the conventional and proposed transportation technology is almost totally dependent on liquid fuels with little room in the foreseeable future, even through 2000, to be able to share that dependence with fuels in other forms. The second symptom, I should add, that most of the fuels are, of course, petroleum liquids, and that increasingly transportation will compete for liquid fuels with other end use sectors.

With these preliminary remarks in mind, I would now like to go through some key point findings and once again remind you that the back-up for much of them is in the many NTPSC reports. Therefore, for brevity, I'll try to keep the talk to highlights.

The first part of the problem is of course how we got where we are and what are the potential for changes. In brief, the consumption of petroleum by the American economy over the last 30 years has been undergoing a change whereby consumption has exceeded or is exceeding our ability to provide new domestic oil to our reserves. Thus the liquified fuel gap is being increasingly filled by imported fuels and those imported fuels cost, in addition to dollars, subsequent devaluation of the dollar, inflation, and loss of domestic jobs and domestic investment because the money has gone out of the country. The cost of this fuel has increased exponentially from almost nothing, to a skyrocketing take-off from the '73 period where in 1978-79 we're talking about 45-60 billion dollars as an oil bill. This is of course, a large sum of money which has a rather concerted impact on the U.S. economy. The transportation sector plays a key role as it is singly the largest consumer of petroleum and petroleum products.

We do not foresee, as I will show briefly later, any significant changes in terms of new transportation technology that will allow us to switch fuels with the notable exception of alcohol fuels and in post '85 of synthetic creation of petroleum fuels. In order to develop alternative fuels (synthetic fuels) that will perhaps displace some crude oil and at the same time allow our transportation sector to operate in an efficient manner, we have to look ahead to see what technologies are on the slate and where we can look for breakthroughs. These synthetic liquids may be alcohol fuels, liquid coal fuels, or oil shale. We note there is an increasing amount of competition of those liquids over time. Many new industries are using petroleum or petroleum dry products as chemicals; and transportation must compete for this petroleum.

A characteristic of synthetic fuels is that not all of them are at the same stage of development. For instance, there is ethanol derived from grains in the form of alcohol fuel that could be used in gasahol as a fuel extender and octane booster today, whereas many of the non-conventional synthetic oils derived from coal as well as shale crude are many years away. There is very little new domestic supply except alcohol fuels from the period now to '85. For coal derived liquids and shale, we are looking in the post '85 period and perhaps in the '90-'95 period for large amounts to be produced commercially. So our short term mobility is very dependent on conservation and alcohols.

In Table 1, I tried to sum up some of the characteristics facing the fuels industry with driving forces and constraints. An understanding of these forces and the constraints will better enable us to make a real estimate of what we have to do, what it will cost, where it will be, and when it will be feasible. The main driving force is depletion of domestic resources and the desirability for both security reasons and balance of trade to develop a domestic alternative. Of the constraining factors key once are capital, and the uncertainties associated with unknown environmental impacts.

Table 2, also from the National Transportation Policy Commission report, shows a quick and dirty production of some of the fuels. The total plant capital costs are quite large exclusive of the necessary transportation and infrastructure to move the fuel products to the factories. We are talking about billions of dollars. The key question that affects transportation both as a user of fuel as well as a mover of fuel is where we can expect the fuels to develop - what regions of the country - certainly transportation will play a key role here. And since coal is one of the key fuels for utility boilers perhaps it will free up some crude oil for transportation. Coal may also be used as a major feedstock for production of synthetic fuels.

The following is a quick glimpse of the Transportation Commission's report of some of the key regions where the coal is deposited. Using the coal regions, we have projected the major commodity flows we feel will be occurring as these fuels come on line over time and try to fill the need for liquid fuels.

The interregional transport of western synthetics in 2004 will include shipments from large development in the west of synthetic crude, synthetic gas from the Northern Great Plains, and the Rocky Mountain region. The report depicts the growth of synthetics all over the country. As a consequence of both the declining reserves of domestic petroleum fuel as well as a necessity to develop synthetics to fill the gap there is the imperative need for a transportation structure that will take these fuels

and move them to where they enter into our existing distribution system. One of the key parts of the distribution cycle is the refining system to convert principal synthetics like coal into liquids, bring those liquids to refineries, and refine them into the products that service the traditional fuel markets. Transportation is of course a large proportion of this network.

Now if we move over time - 25 years - in our projections we will see in Chicago by 2000 a vast change to meet the East North Central demand for gasoline. Other refinery regions will be called in to help, including the Gulf Coast, the West North Central and the West Coast Port Regions. A variety of sources of the feedstock for the liquid synthetic fuels, reflecting the dwindling conventional domestic crude, will service the refinery regions. A lot of coal derived crude will be moved from Appalachia, the Great Plains, and the Rocky Mountains to the Chicago region and finally wind up as refined products to meet the East North Central demand. This means additional hook-ups and pipelines in regions where there are no pipelines at present, and thus the necessary transportation structure in pipe, barge, rail and truck, to meet the demand. So, indeed transportation will play a key role in making the synthetic dream come true.

I would like to highlight some of the key trends and findings and comment briefly on them. First, is that fuel for transportation or transportation needs for energy will depend mostly on liquid fuels as a primary source, as well as other liquids like alcohols and other synthetics. The availability of an adequate supply is going to depend on an effective development of commercial synthetic facilities, a rapid commercialization of alcohol facilities, a maximum utilization of coal for use in industry and as a substitute for our liquids for transportation, and our treatment of rather high efficiency fuel vehicle economy standards.

Although we are seeing a lot more conservation in the transportation sector, hence a decline in the rate of consumption of liquid fuels, the demand is still substantial due to the growth in size of population, particularly the driving age portion of the population. We will see a slight increase in growth of total motor fuel usage. Part of that fuel however, will be diesel. There will be many constraints on this supply as well as on the demand from environmental, safety or pricing regulations.

I urge you to read the NTPCS report, and in particular, the energy chapter and the forecast chapter. The supporting documents are numerous and it is expected that they will be available some time in the future through NTIS. Thank you very much.

Synthetic Fuels Industry

Driving Forces

- Depletion and cost escalation of conventional domestic energy supplies
- Shortages of environmentally acceptable fuels
- Constraints imposed on alternative energy systems
- The presence of existing fuel distribution systems
- A seemingly chronic negative imbalance in foreign trade and payments accounts
- National security
- Governmental incentives.

Constraining Forces

- Technological and economic factors
  - Product costs/markets (interfuel competition)
  - Status of technology and technological risk
  - Financial risk
  - Capital availability
- Environmental and social factors
  - Air quality
  - Water quality
  - Land reclamation
  - Social dislocation
- Availability of resources
  - Energy resources
  - Water resources
  - Land/site availability
  - Skilled work force
- National, state, and local policies.

Table 1

PRELIMINARY PROJECTIONS

	PRODUCTION IN QUARD/YR		NO. OF PLANTS		TOTAL PLANT CAPITAL COSTS (BILLION $)	
PRODUCT	1998	2004	1998	2004	1998	2004
CRUDE						
Total	1.746	10.833	9	55	15.8	98.1
Gr. Plains	1.720	10.800	9	55	15.6	97.8
Rocky Mts.	.026	.033	1	1	0.2	0.3
LNG						
Total	.415	1.382	5	17	3.5	11.9
Gr. Plains	.413	1.314	5	16	3.5	11.3
Rocky Mts.	.002	.068	1	1	0.1	0.6
SHALE						
Rocky Mts.	1.270	4.233	6.6	22	2.5	8.4
TOTAL	3.431	16.448	21	94	21.8	110.4

NOTE: Costs in 1975 constant $

Table 2

OIL SHALE AND TRANSPORTATION

PAUL A. PETZRICK
DEPARTMENT OF ENERGY

It is certain that as we look at additional energy resources we can identify many new transportation problems. Your meeting is therefore timely and your initiative is to be commended.

Before we discuss transportation problems for oil shale, I want to justify that oil shale is the transportation alternative. The present energy shortage is in reality a shortage of cheap conventional forms of energy and in particular a shortage of liquid fuels for transportation. It is no accident that petroleum has become the mainstay fuel for transportation.

The liquids prepared from petroleum have that unique combination of energy per unit volume and energy per unit weight, combined with safe handling properties that have made them ideal for mobile equipment. Oil shale offers the cheapest large scale alternative to petroleum for the production of liquid fuels having these properties.

Without going into detailed discussion of cost estimates, let me just say that the subsidy we need now for oil shale is about five dollars a barrel. You can make your own comparison with the amount of subsidy being requested for the other alternatives for producing liquid fuels. In addition to the advantage of cost, oil shale offers some other important advantages as a transportation fuel. It has an improved yield of middle distillate fuels even over petroleum. We note a trend in studies toward increased use of diesel fuel. Oil shale has an advantage in safety in that it has low aromatic content providing a particularly high yield of kero base jet fuel. This makes it particularly attractive to the aviation industry. It may actually be possible that as we produce more and more shale oil, we will reduce the amount of aromatic material in commercial jet fuel and thereby increase the safety of aviation operations. Probably the most important advantage of oil shale is that it is compatible with the existing refinery and distribution system serving the transportation industry in this country. Even if we were to find a perfect alternative that was plentiful, if it could not use the existing distribution system, there would be many years of effort and enormous dollar expense associated with establishing a new fuel distribution system for the country.

Thus, oil shale may be viewed as a timely alternative even though we are faced with some enormous problems to bring production on stream at the rate the President would like.

With regard to timeliness, let us consider briefly just what is involved in commercializing a new natural resource such as oil shale. This is not to say that oil shale is new. The existence of the mass of oil shale deposits has been known since the pioneers first traveled in this area and made the first transportation use of oil shale making axle grease for their wagons. What is new is the national conviction that we must use it for an alternative to imported petroleum. In any case, in addressing the question of commercializing any natural resource, three basic elements are examined.

One, is there sufficient resource to justify a commercial operation?

Two, is there an economical extraction technology?

Three, is there a market for the product of the operation?

Regarding these three elements, the nation has two trillion barrels of shale oil in the rich deposit in the Green River Formation in the West and twenty-six trillion barrels in the leaner deposits throughout the Nation. This can meet our transportation needs for thousands of years.

Control of the resource by the private sector in the West has been a problem because eighty percent of the resource is on public lands.

This is an issue that is receiving careful attention as we plan for the growth in shale oil production to meet the President's goals. It may be that we will have to consider producing possibly somewhat more expensive shale oil from the Devonian deposits to meet the more ambitious national goals.

The socioeconomic impact and strain on the environment and water supplies in the West may be too great to manage if we try to produce all of the shale oil in that part of the country. In any case, there is in the twenty-eight trillion barrels of shale oil in the continental United States an adequate resource for thousands of commercial shale oil operations.

The extraction technology is somewhat uncertain because commercial operations in shale oil have never been carried out on the scale that must now occur in the United States. In general, we believe that surface technology is ready to scale up to commercial operations. More work is required to prove the reliability of the in situ technologies. The economics of these technologies is such that we have proposed a three dollar per barrel tax credit which will shelter between five and six dollars per barrel of income for a company producing shale oil.

The capital investment associated with this technology is enormous - on the order of a billion dollars per fifty thousand barrels per day plant.

We are, therefore, supporting legislation that would provide some protection from catastrophic loss in the event of an unforseen change in world oil price. Under these conditions, the market for shale oil will be barrel for barrel replacement of imported petroleum. The raw shale oil produced directly from the retort does have to be upgraded to be compatible with existing refineries. It is uncertain whether this upgrading will take place at the oil shale plant or at existing refineries. Regardless of where upgrading occurs, synthetic fuel prepared from shale oil will be a premium refinery feedstock, an excellent source of middle distillate fuel, and an excellent blend material to prepare broad range refinery feedstock from the heavy oils which are predominating new petroleum discoveries. Thus, oil shale meets the test of the basic three elements for commercializing a natural resource. For those of us who have worked in oil shale for a number of years, we note with promise that the President's energy plan now contains all the support necessary for such commercialization to occur.

Regarding the transportation of shale oil, it is our opinion that in the long run transportation questions will not pose a very serious threat to the development of a healthy and prosperous shale oil industry. The marketing research firm of Purvin and Gertz, in a recent transportation analysis performed under contract to Occidental Petroleum, has concluded that sufficient existing pipeline capacity (through the Amoco and Platte pipelines) should be available to move more than the projected two hundred thousand barrels per day from Occidental Colorado-based production to midwestern and north central states refineries by the early 1980's, when production is expected to reach that level. On the other hand, in the near term - over the next several years - important transportation problems must be overcome.

Highways: Almost all of the areas where oil shale will be mined and retorted are in remote areas of Colorado, Utah and Wyoming. Comprehensive transportation systems to support commercial-scale oil shale operations do not now exist there, and a battle is certain to be waged between pro and anti-development forces before such systems can be developed. Although major all weather highways exist in the general area now destined for oil shale development, the highway situation within immediate project areas is not always adequate. Dirt roads in and out of mining areas still are prevalent. A general upgrading is also required for major support roads linking mine and retorting facilities with major railway trunk lines, as well as for roads serving as conduits for shipment of supplies and large pieces of equipment from trunk lines to the mine and retorting areas. Finally, shale oil competes for many of the larger highway systems with coal and other mineral resources. Shale oil shipment will only thus add to the need for increased highway upgrading and highway maintenance of large intra- and interstate roads.

Railroads: Only two railway systems serve the general geographical area - to the South, the Denver and Rio Grande Western Railway; to the North, the Union Pacific. If agreements for laying additional rail spurs or other railway system support cannot be made with one of these two companies, a developer is simply out of luck. Also, Denver and Rio Grande Western and Union Pacific trunk lines do not directly intersect present and planned shale oil development projects. A one hundred mile rail spur to link up with the main Denver and Rio Grande Western trunk line in Colorado has been talked about by the railroad, but no specific action has yet been taken. Due to rugged, mountainous terrain and pristine environmental conditions, construction of a rail spur line might prove prohibitively costly.

Whether a commercial scale shale oil industry can ever be adequately supported by a transportation system of roads linked to major trunk lines is rather doubtful. The railroads certainly have the freight car capacity, especially with unit car systems. The problem is with the highway tanker truck link.

Pipelines: Pipeline systems from mine and retorting sites linking up with interstate pipeline systems and thence to major refineries offer the best, and probably the most economically feasible, means of transporting shale oil in the future. Purvin and Gertz, in their study for Occidental Petroleum, have determined that shale oil can be transported by pipeline to midwestern and north central refineries at a per barrel rate less than domestic crude oil from the north slope of Alaska, or imported oil from Indonesia or Saudi Arabia, and they feel fairly sure that capacity will remain available.

A feeder line would have to be built from northwestern Colorado to Casper, Wyoming, to feed the Amoco and Platte lines. The Northern Pipeline Company has shown interest in constructing such a line. There is presently some small spare capacity in the Amoco pipeline which now runs between Rangely, Colorado, and Wamsutter, Wyoming. Yet Amoco is not enthusiastic about using this spare capacity for shale oil. They feel that a new, more direct route between northwestern Colorado and Casper could be more economical in the long run.

Several other alternative routes for the transport by pipeline of shale oil out of the Rocky Mountain area have been discussed. One is to construct a pipeline between the Uinta Basin area of Utah and Casper. However, the decline in Wyoming crude production and skepticism regarding the prospects for appreciable new production in the area have temporarily put a halt to such an idea. Another proposal is to build a southern tie to the Pure Company pipeline at Lisbon, Utah (either from Utah or northwestern Colorado) or to the Four Corners area of Utah, Colorado, New Mexico, and Arizona to link up with the Texas-New Mexico pipeline and thence to Gulf Coast refineries. The problem with this idea is that the Texas-New Mexico pipeline is used primarily to hook up with the petrochemical refineries of the Gulf Coast. Also, the Texas-New Mexico pipeline is in very poor condition. Still another alternative is to reverse certain Wyoming pipelines to supply northern tier refineries with shale oil crude. This would have to assume that a northern tier pipeline linking Alaskan oil with the northern tier would not be constructed. Purvin and Gertz feel that even in the unlikely circumstances that some new source of crude is found to absorb the spare capacity of the Amoco and Platte lines, it may still be possible to move crude shale oil by these pipelines. They are common carrier pipelines and as such have limited rights to deny movement of crude through their systems.

Although in the long run it seems possible that pipeline systems will be the chief means by which shale oil will be transported from mine to refinery, in the short term there are some sticky pipeline problems which need to be resolved. For example, a large feeder pipeline from shale oil areas to interstate pipelines will involve enormous capital expenditures, and environmental and socio-

economic impacts of pipeline construction can be serious. Although it will be easier to construct a feeder pipeline than a railway spur in the rugged, mountainous oil shale areas, significant impacts and regulatory problems can be expected. In addition, the physical design of the pipeline itself may prove a problem. A large feeder pipeline will probably involve a joint venture by several companies - it would be environmentally unsound and economically wasteful to construct industrial pipelines for various company projects. Yet as of now no design work for a feeder pipeline has been completed. There will be a need for intra-industry negotiation on the exact design and the exact placement of such a feeder pipeline before such a project can get underway.

Finally, there may be special pipeline design problems because of the nature of shale oil and the particular climate of the area through which it will traverse - for example, it might be found that the pipeline will have to be heated or that because of its weight, numerous pumping stations will have to be built along the way, or that because of its nitrogen content, shale oil will have to be segregated on intrastate pipeline runs - all exacerbating the cost and environmental problems already mentioned.

In conclusion, I think it can be said that in shale oil we have a resource with great potential impact for alleviating some of this nation's burden regarding our lack of adequate domestic liquid fuel supplies. Not only is oil shale abundant, its products are particularly useful as a transportation fuel, having distillate yields which meet needed diesel and jet fuel requirements, as well as providing an excellent refinery feedstock for gasoline. Regarding transport of shale oil, in the near term a truck-rail transportation system will suffice to bring the initial production from mine area to refinery. However, once commercial levels of shale oil are produced - fifty thousand barrels of oil per day and more - the only economical and environmentally feasible means of transport will be by feeder pipeline system linking up with major interstate pipeline systems and thence to refineries for processing.

THE INFLUENCE OF TRANSPORTATION CONSIDERATIONS UPON THE ECONOMICS OF GASOHOL, Pincas Jawetz Consultant, New York, NY

Gasahol is a mixture of gasoline and alcohol in which the alcohol is used as an extender of the supply of gasoline. One particular composition is called gasohol (with an "o") and is defined as a mixture of 90% gasoline and 10% ethyl alcohol. The alcohol is produced by fermentation of a renewable resource. The gasohol quantitative relationship may not constitute the most favorable composition, but one will use this here in deference to its wide-spread acceptance.

The requirements of the United States for motor-vehicle transportation are:

1. To boost the octane rating of unleaded gasoline by three points to satisfy motor vehicle needs for a higher octane fuel (without using lead or manganese compounds).
2. To keep the price differential between unleaded and leaded gasoline at no more than three cents/gallon to discourage fuel switching from unleaded fuel to leaded gasoline.
3. To try to use indigenous resources of a renewable nature.

Gasohol does in effect favorably answer these three requirements. As we shall proceed to demonstrate gasohol does in addition present a saving of petroleum and petroleum products much higher than one would assume from a mere 10% substitution. In effect, if one were to produce an octane boosting additive via catalytic reforming, hydrocracking, alkylation and isomerization processes that create streams rich in aromatic compounds, or branched aliphatic compounds, one would have, according to an American Petroleum Institute testimony (1) to spend an additional 6% of crude. In private communications from knowledgeable sources, I have learned that the amount of crude lost in such processes, depending on the type of crude, may be as high as 15%. Assuming the A.P.I. numbers one can say that 10% ethanol displaces 16% petroleum crude and petroleum products (2).

In addition to the replacement of the petroleum or natural gas based octane booster, the addition of ethanol to gasoline also improves the performance of the car as measured in miles/gallon. This observation is remarkable when one considers that ethanol has only about 2/3 the value in BTUs of gasoline and when considering also an improvement of miles per gallon in the range of 5-6% (3), one can develop a series of factors that prove one BTU of ethanol effectively displaces 3.75 BTUs of gasoline (4).

The economics of the production of fermentation ethanol are extremely favorable when one allows for changes in farm policy. As an example, we will mention here that at the time of the 1978-1979 agricultural season a total of 18.7 million acres of cropland were subsdized by the U.S. Department of Agriculture to be kept out of production. If instead this land would have been planted in corn for alcohol and the existing subsidies for non production changed to subsidies to the distiller, this country could have had 115 million barrels of ethanol; the cost of which could have been subsidized by amounts of up to 62 cents per gallon of ethanol. More exact subsidy levels have been brought forward at different Congressional hearings (4,5,6). The final cost of a gallon of alcohol, using such methods, could easily be competitive with the price of gasoline.

Fermentation alcohols should not be regarded only as octane boosters and as sources of energy. Their future importance is also going to reach into the area of feed-stocks for the chemical industry and this subject was recently included at a United Nations Industrial Development Organization (UNIDO) workshop.

To draw to a conclusion this part of our presentation, fermentation alcohols have been obtained from potatoes, corn, sugar cane, cassava, wheat, beets, from agricultural by-products, and from the products of the hydrolysis of cellulose. They can then be used for a variety of purposes in our petroleum short economy.

Fermentation ethanol is produced in a distillery. The transportation considerations that will influence the alcohol industry are in effect the considerations that will determine the size and the location of the distillery.

One has to bring the primary material to the distillery and then transport the outputs to the place where they are needed. Where is the alcohol to be mixed with gasoline -- at the refinery, at a central mixing depot, in tank cars, or at the gas station? In addition to alcohol the distillery also produces animal feed, CO_2 and fusil oils. If a small distillery is built the animal feed does not have to be dried as the wet slop can be used in the vicinity of the plant. Dry animal feed can be produced for export. Are we going to build small distilleries on farms and are we going to develop machinery that will use pure alcohol? What seasonal utilization and what storage capacity are we envisioning?

As we see the list of transportation related questions is large. The answers to these questions and the changes in farm policies could make it possible to develop a new economical system for supplies of energy and chemical feedstocks. This system, when planned correctly, will not require any massive governmental aid beyond existing agricultural subsidy levels.

The Department of Energy has just released a study of the potential of alcohol fuels (7). This study constitutes a definite improvement upon the Department of Energy understanding of the subject but is still lacking recommendations. One hopes that the newly created National Alcohol Fuels Commission about which Edward Bentz spoke last night will provide the right answers to the questions posed in this presentation. The Commission was chartered for one year and its task is to perform studies that will enable a national development of the fuel alcohol resource - hopefully from renewable sources rather than from coal, and also hopefully without too much further delay. I suggest we identify the above

mentioned subjects for needed research as an important part of the recommendations of our conference. I believe that with the Administration's help, or without it, fermentation fuel-alcohols are here with us to stay. Meetings, like the UNIDO meeting this past March in Vienna, are making our indecisions on power alcohol the laughing stock of any nation that considers seriously the need to decrease its dependence on foreign oil.

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RAIL TRANSPORTATION OF ENERGY MATERIALS (HAZARDOUS MATERIALS)

Patrick J. Student, Association of American Railroads

The rail transportation of energy materials that are hazardous materials is growing. More carloads of energy materials in larger capacity tank cars are moving on our railroads to provide needed fuel to industry and the consumer. Energy materials can move in approximately 55 percent of the current tank car fleet due to practical or regulatory considerations with some specific commodities such as ethylene requiring specialized equipment. Energy materials represented 16 percent (approximately 200,000 carloads) of all hazardous materials traffic in 1978 and this can be expected to increase. In terms of accidents and incidents involving energy materials, the picture is improving with fewer leaks, fewer tanks derailed and those with any lading loss. The largest single impact on the future movement of energy materials appears to be the conflict between regulations of DOT and other federal agencies and state and local jurisdictions.

I wish to discuss rail transport of those energy materials that are hazardous materials, the liquefied petroleum gases, gasoline, fuel oil and crude oil.

I. Tank Car

First I would like to talk about the vehicle in which these commodities are shipped, the tank car. If this conference were being held during THE crisis of transportation of energy materials of thirty-five or so years ago, I'd mention two tank cars and that the problem of producing more cars depends on manpower and materials allocations.

Figure 1 shows an ICC 103 specification tank car used for the transportation of gasoline, fuel oil, and crude oil, as well as other commodities. These cars were of typical 8,10,or 12,000 gallon capacity, though there were a few 16,000 gallon tank cars around. Fusion welded cars similar to these were built beginning in 1941. The car builders would build these cars in large lots, typically 1,000 to 2,000 cars including speculative building to attain these large lots.

Figure 2 shows an ICC 105 specification tank car used for the transportation of liquefied petroleum gases, natural gasoline and certain other liquefied gases. These cars were of 11,000 gallon capacity. Like the 103 specification tank cars these too were built in large lots.

Now, if this were my imaginary conference of the war years, I'd finish by saying that to move more oil etc. more cars are needed and this is up to the allocation boards.

Continuing with the typical cars of today figure 3 shows a 21,000 gallon 111A specification tank car used for transporting gasoline, fuel oil or crude oil. Cost of this car is $41,500. The same but insulated and with 12 lines of exterior heater coils is $51,200. A 30,000 gallon tank car noncoiled and uninsulated for transporting alcohol or gasohol would cost $44,000.

Figure 4 shows a 33,000 gallon 112A specification tank car used for transporting liquefied petroleum gas. It is uninsulated and was the typical car used for transporting this commodity. Among other items the regulations are now requiring this class of tank cars to be retrofitted with a thermal protection system if it is used to transport flammable compressed gases.

Figure 5 shows a 33,000 gallon 105A specification tank car which is the current new construction for transporting liquefied petroleum gas. The cost of one of these tank cars is $53,000.

I was told that I would be asked about rail transport of liquefied natural gas. Figure 6 shows the tank car that would be used to transport this commodity. The only commodities transported in this class of tank cars so far are liquid ethylene and liquid hydrogen. It is a specification 113C tank car. It is constructed as a tank within a tank with 10 inches of insulation. When the car is shipped, a vacuum of at least 75 microns is pulled in the insulation space. Because of the elaborate insulation/vacuum system these cars are maintenance heavy. One can count on these cars being out of service 1 to 3 months a year. The cost for a 113A tank car used to transport liquid hydrogen is $250,000, for a 113C for liquid ethylene service is $200,000.

The current tank car fleet is about 180,000 tank cars, and not all tank cars from either a practical or a regulatory stand point can be used to transport energy materials. For transporting these commodities only about 20,000 103's, 50,000 111A's, 15,000 105A's (including about 5,000 of the size shown on figure 5) and 15,000 112A's can be utilized. Of the 113's there are 26 113A's and 55 113C's.

Almost all of the tank cars are owned by private companies, not the railroads. The railroads own

Figure 1.

Figure 2.

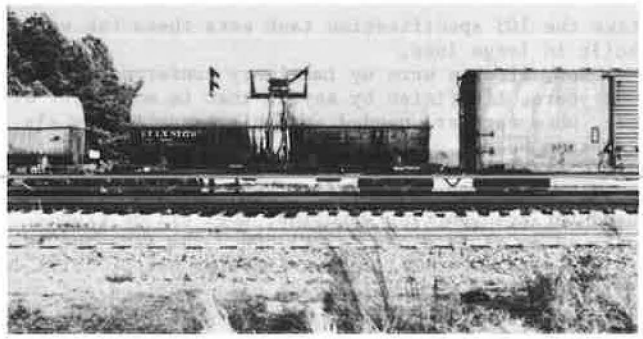

Figure 3.

Figure 4.

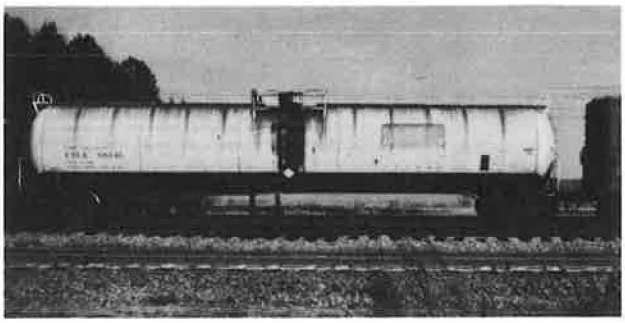

Figure 5.

Figure 6.

about 5,000 tank cars which are mainly used to haul fuel oil about their systems.

II. Traffic

The railroads move between 23 and 24 million revenue carloads per year. Of these between 1.1 and 1.2 million are hazardous materials. The growth of hazardous materials traffic is between 4.5 to 5 percent per year. A little more than 80 percent of this traffic is in tank cars.

Energy materials (liquefied petroleum gases, gasoline, fuel oil) accounted for 18.5 percent of the hazardous materials traffic in 1977 and 16 percent in 1978. This decline should not be considered significant since carloads increased and the quantity of materials transported increased at an even greater rate. This latter fact is due to the increasing average capacity of the tank cars used for transporting energy materials.

Over half of the revenue carloads of energy materials is liquefied petroleum gas (propane, butane, propylene, etc.) While the commodity is shipped year round it does exhibit a definite shipping season - September through March with a peak of November - December. With the opening of several gas fields in the West, the railroad industry has been advised of approximately a 50 percent increase in the revenue carloads of liquefied petroleum gas in the next year.

Gasoline now only accounts for 10 percent of the energy materials carloads and only originates from a few points in the western United States.

Fuel oil appears to be growing in carloadings from 1977 to 1978. The number of carloads increased almost 4 fold to 20 percent of the energy materials revenue carloads. This increase may be somewhat misleading as fuel oil was considered nonregulated up to 1976 and many people still don't consider it so, and hence, don't properly describe it to the rail carriers when the material is tendered. Further this does not count fuel oil moving as company material. As the railroad is moving the material from one point to another on its own line for its own use, there is no charge for its move and it is not reported outside the company.

In terms of car miles a typical carload of hazardous material (energy materials) is hauled about 50 percent farther than the average for all commodities.

III. Accidents and Incidents

Accident as used in the following discussion is any derailment or fire involving a hazardous material. An incident is a leaking tank car of hazardous materials (energy materials).

The numbers given for accidents and incidents are those as reported to the Bureau of Explosives. The Bureau feels that it receives most of the reports on incidents and almost all of the reports on accidents. Further the Bureau feels that there are many more leaking tank cars that are not discovered and hence not reported.

For all hazardous materials in 1977 the Bureau received reports of 765 leaking tank cars, 475 tank cars involved in derailments of which 103 lost some lading. For 1978 these number were 863, 734 and 157 respectively. These numbers do not necessarily represent more accidents but better reporting. After the weekend of Waverly and Youngstown the railroads seemingly went out of their way to report accidents and incidents to the Bureau. A large number of these cars only had a wheel set or truck derailed.

With regard to energy materials in 1977 there were 138 leaking tank cars, 107 tank cars derailed and 22 of these lost some lading. For 1978 these numbers were 106, 121, 14.

In these cases where a car is indicated as losing lading, this could be a dripping about an unsecured valve, the amount that seeped into a bottom outlet chamber that was sheared off in the derailment, or the loss of the entire contents due to a valve being sheared off or the tank being punctured.

Leaking tank cars of liquefied petroleum gases constitute one of the largest groups for all commodities. If the shipping season is taken into account along with the fact that most of the loading rack personnel are last hired - first fired, then the reason for this problem is somewhat understable. In an attempt to counter this the Bureau maintains a field force of 19 inspectors in the United States and Canada who among their other duties visit plants where cars that have been discovered leaking were shipped in order to work with the shippers personnel by showing then what was wrong with the car and how to prevent it from reoccurring.

IV. Future Consideration

An increase in traffic of hazardous materials (energy materials) beyond the historical growth rate does not present a problem to the railroads. Problems involving hazardous materials do arise because local jurisdictions and federal agencies other than the Department of Transportation issue regulations which conflict with or are more restrictive than those of the DOT.

Examples of these would be local routing restrictions similar to the New York City ban on highway transport of radioactive materials or the proposed requirements to "pre-notify" local/state authorities of the movement of hazardous materials through a state. On the federal level, the EPA Hazardous Substances Regulations are conflicting with the DOT Hazardous Materials Regulations.

In the case of local regulations, the Department of Transportation can preempt, but beyond this, the problems that have been arising are two fold:

First, the shipper can specify the routing of his shipment and the railroads are obligated to follow such orders. The problem is even more difficult than appears because shippers in one state are not governed by the requirements of another state. Second, a railroad is required to move expeditiously any carload of hazardous materials it receives. The delaying of a shipment in order to report its movement to a political jurisdiction goes against this requirement. Also, in many locations one railroad turns a complete train over to another railroad just before a governmental boundary. Finally, there is the inescapable question of what is the political jurisdiction going to do with all the reports it would receive?

In the case of the Federal agencies, in 1978 the EPA issued its regulations on hazardous substances together with a list of designated substances. Many of these commodities were the same materials as on the DOT list but by different names. Even though not requiring the shipper to tell the carrier that a hazardous substance had been tendered, the EPA nevertheless expected the carrier to report any time it spilled one of these substances. This insanity was cited by the Federal judge who enjoined the EPA from enforcing this regulation. This entire subject is now being addressed by the Department of Transportation in its regulations. This problem shows the need for a single set of regulations governing the transportation of hazardous materials. Such a unified code would contain the information

that would allow the carrier to satisfy the requirements of each of the several regulatory bodies.

AN ALCOHOL FUELS PROSPECTIVE: THE NATIONAL ALCOHOL FUELS, Edward J. Bentz, Jr. Executive Director National Alcohol Fuels Commission

INTRODUCTION

On July 18, 1979 the National Alcohol Fuels Commission, created by the Surface Transportation Act of 1978, held its first meeting. At the first meeting - open to the public - an organizational framework and work plan were adopted. That work plan attempts to answer the following basic questions enumerated in the enabling legislation creating the Commission: Why study alcohol fuels? What can alcohol fuels provide the nation - in both short and the long term? When will they be available? How much will they cost? What is their relationship with other synthetic fuels and conventional fuels? What current or new technologies hold promise for alcohol fuel development? What has been preventing or impeding their introduction into the fuel mix to other markets? What programs or policies has the Federal government created to realize their potential commercialization? What programs or policies should the Federal government institute to rapidly catalyze the commercialization of these fuels in the most efficient and timely manner? .... and finally, what is the long and short term potential for alcohol fuels to displace foreign crude and promote domestic economic benefit?

MEMBERSHIP

Six U.S. Senators, six U.S. Representatives, and 7 private citizens comprise the 19 member Commission. The Senate members were appointed by the President Pro Tempore. The House members were appointed by the Speaker of the House. The Congressional delegates to the Commission were appointed from the respective committees on appropriations, agriculture, and energy. Senator Birch Bayh (D-Ind.) chairs the Commission. Representative Robert A. Roe (D-N.J.) serves as Vice Chairman. The seven public members were appointed by President Carter and formally inaugurated on June 27, 1979 at a White House ceremony conducted by Vice President Mondale.

MANDATE (from enabling legislation P.L. 95-599 Section 170)

SECTION 170(2) reads

"The Commission shall make a full and complete investigation and study of the long- and short-term potential for alcohol fuels, from biomass (including but not limited to animal, crop and wood waste, municipal and industrial waste, sewage sludge, and oceanic and terrestrial crops) and coal, to contribute to meeting the Nation's energy needs. It shall take into consideration the technical, economic, legal, environmental, and social factors associated with the production, manufacture, distribution, and use of such fuels. It will evaluate the costs and benefits of alternative feedstocks and their possible end uses, and analyze the feasibility and desirability of converting these resources to alcohol fuels. Based on such study it shall recommend those policies, and their attendant costs and benefits, most likely to minimize our dependence on petroleum, insure adequate energy supplies, and contribute to the economic health of the Nation."

SECTION 170(c) reads:

Such report shall include the Commission's findings and recommendations with respect to --

1. The long- and short-term potential of alcohol fuels contributing to domestic energy supply.

2. The relative costs and benefits of developing alcohol fuels from alternative feedstocks, taking into account technical, economic, legal, competitive, environmental, and social factors associated with their production, distribution, and use; their most appropriate end uses; and a recommended time frame for their introduction into the Nation's energy mix.

3. The existing policies and programs of the Federal Government which affect the development of such alternative fuels; and

4. New Policies and programs required to develop alcohol fuels from coal and alcohol and other fuels from the biomass to meet the Nation's projected short-term and long-term energy needs.

STUDIES PLANNED AND UNDERWAY: (as of 7/18/79 organizational meeting)

° Net Energy Balance, study to assess one, what is the appropriate measurement technique for assessing the net energy balance of fuels; and two, using that technique for obtaining net energy balances for both conventional as well as novel fuel technologies (ethanol and methanol).

° Food vs Fuel, a series of studies assessing the crucial relationships and dependences of alcohol fuel production and food/feed production. Studies will include current relationships as well as projected change due to crude oil price and supply changes, alternate supply feedstocks and agricultural and energy policy variables.

° Distribution Requirements for Alcohol Fuels, assessment of physical and institutional requirements needed and barriers to the inexpensive carriage of alcohol fuels.

° Underutilized Distillery Capacity, an assessment of short-term ethanol production capacity in the U.S. Includes an assessment of current idle distillery capacity as well as additional peripheral industrial buildup.

° Transportation End Use Study, an assessment of the current and projected technologies for use of alcohol fuels in the all important transportation sector.

° Methanol Supply, Demand and Usage, an assessment of the supply, demand and usage of methanol from coal and biomass.

COMMUNITY IMPACTS AND LOCAL AUTONOMY
William A. Brobst, Moderator
Warren B. Lovejoy, Hays B. Gamble and Kathleen Stein Hudson, Panelists

H. B. GAMBLE:

The raw materials sources for most forms of energy -- petroleum, coal, uranium, geothermal, hydro -- are found in very specific locations throughout the world. In most cases, these raw materials must be extracted, moved to a point for processing or refining, and the resultant energy form then delivered to the ultimate consumer. In the case of petroleum, coal, and uranium, the waste products or by-products of processing and generation must then be transported to disposal sites. It would be interesting to tally the total amount of energy required to move energy from original source to final consumption. My guess is it would be staggering. For example, take a mine-mouth power plant in Pennsylvania. The coal must be moved from the mine head to the shaft, up the shaft, thence to the breaker, washer, and grader, and then to the power plant. Or, if not a mine-mouth operation, then from the mine (deep or strip) to the coal washer and breaker, thence by rail or truck to the power plant. At the power plant, the coal is stored in large outdoor piles. It must be moved to the boilers. The power, of course, is transmitted over high-power transmission lines, sometimes hundreds of miles to the point of consumption, with energy loss all along the way because of line resistance.

Back at the generating plant, fly ash and sulphur oxides scrubbed from the stack gases must be transported to disposal points. There is plenty of this stuff. At one large plant in Indiana County, about every 20 minutes a 15 ton dump truck leaves with a load of this toothpaste consistency gunk.

What proportion of the total amount of energy embodied in the original ton of coal was represented by the energy required to accomplish all of the transport discussed above? That would be an interesting figure to see. I suspect that to move a barrel of petroleum from deep underground in Saudi Arabia to the finished product, gasoline, on the service station dealer's underground tank in Potter County, Pennsylvania, is even less energy transport efficient.

There is one major source or form of energy that we have not considered. In terms of energy transport it is quite important -- in fact it is a question of survival. I am referring to food. If we talk about transport of energy, shouldn't this include the transport of the principal source of energy for human life -- food? Now if we add together all the energy required to transport to farms all the necesary inputs required by modern agriculture, to move all the farm products from farms to processing plants, move the processed foods thence to distribution centers and retail stores, and all the energy embodied in consumer shopping trips, we have a real dandy subject for research. I have not been too turned on by the subject of this conference thus far. Relative to other energy and transportation issues and problems it appears to me to be quite minor. But if we consider foodstuffs as an energy form, then I think we have a relevant topic.

For one thing, it strongly involves the issue of land use, and this is almost always a timely topic. A research endeavor at the University of Massachusetts -- the METLANDS project (1)-- examined the total energy requirements in locally produced food versus food produced in the traditional food specializing regions in the country. There were some interesting results. A gallon of milk produced in Northcentral Massachusetts required 74 percent less energy than a gallon of milk produced in Wisconsin by the time it reached the consumer. These figures include the energy consumption of the more efficient Wisconsin farms. A community of 10,000 people in Massachusetts would require an additional 305,457 gallons of diesel fuel if all of the apples it consumed came from Washington rather than from local orchards. This suggests an important new dimension in the arguments for conserving agricultural land in urban fringe areas. Including the high costs of delivering energy in all its forms to the suburban sprawl patterns of settlement so characteristic of most of our urban areas, the study of the relationship between land use and transport of energy becomes even more relevant and important.

In the remaining time I would like to address one specific issue that is important to us here in Pennsylvania as it relates to transportation of energy -- coal haul roads. There appears little doubt that coal will be playing an increasingly important role in supplying the future energy needs of this country, particularly if the energy policies recently enumerated by the President are carried out. Coal, as it comes from either deep or strip mines, must be hauled to a breaker and wash plant, a power plant, or a rail head for shipment. In the future, liquefaction or gasification plants may be included. In many cases, such deliveries involve the travel of very heavy trucks over roads and highways. Except in very rare instances, these are accomplished over local roads rather than interstate highways. In almost every case, local roads are simply not constructed to take the beating imposed by constant heavy truck traffic, particularly in the winter and spring months when the frost is coming out of the ground. As a result, local roads and bridges in many sections of rural Pennsylvania, and other states too, are in a deplorable condition. Moreover, these roads are almost always curvy and narrow, reflecting the kinds of terrain in which most coal is found.

Many of these roads go through small towns and hamlets. The noise, dirt, and dust, not to mention the safety hazards from all of the truck traffic, impose additional burdens on local residents who already must bear the brunt of the environmental costs of mining. Thus we can see the many inequities associated with coal mining.

Townships just don't have the fiscal means to keep these roads in proper repair. The cost of upkeep, or the costs to motorists in wear, tear, and lost time when the roads are not maintained, imposed by the local coal operators and final users, must be borne by all local residents. Thus the costs are borne by one group of people whereas the benefits are realized by another group, the latter usually far removed from the local scene. In a very real sense then, rural people in Appalachia are subsidizing energy costs for urban people elsewhere. The price of energy to the final consumer should include an amount sufficient to cover the costs of road maintenance and the alleviation of other environmental disamenities to local rural communities at the points of origin.

In summary, if we consider foodstuffs as an energy form, and I see no good reason why we should not, then problems associated with settlement patterns, preservation of agricultural lands, and land use in general are opened to us for legitimate inquiry. Second, with coal destined to play a much more important role in meeting our domestic energy needs, ways must be found to more equitably distrib-

ute the costs and benefits associated with moving coal from mine to consumer and the disposition of the waste by-products from coal power generation.

Reference

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PANEL DISCUSSION

W. Lovejoy

I'll concern myself with a discussion of possible transportation of energy impacts in urban areas. Now first of all, I'd like to say that when we get into the subject of impacts, it's pretty difficult, in fact it's misleading, to try to talk in terms of global impacts. What we really have to do is focus on the particular area where we're trying to measure impacts, because each of the urban areas or parts of this country have such different characteristics as far as transportation is concerned and as far as the energy requirements are concerned. I'll concentrate my remarks on the transportation situation as it's likely to develop in energy along the Eastern Seaboard and since I know more about the New York metro area than any other place, I'll start from there in my discussion.

As many of you know, the Eastern Seaboard has quite different characteristics from the U.S. norm in their energy use and therefore their energy transportation problems. All the major urban areas, from Boston down to Baltimore, are heavy users of petroleum. In the New York area, for instance, 75% of the total energy that's used in that large metro area, and that includes northeastern New Jersey, is petroleum and a very large proportion, something like 65 to 70%, of that petroleum is imported. So right off the bat, you can see that whereas we've been talking almost exclusively in the whole meeting of land transportation problems, the major problem that the Eastern Seaboard urban areas have is how to handle the ocean or water movement of energy materials and what does that mean in terms of impacts on the local areas? In 1978, these ports from Boston south to Baltimore received something pretty close to a hundred million long tons of petroleum imports; and that's a lot of petroleum coming in.

Conversely, with a few exceptions, because of transportation costs or problems and/or environmental restrictions, the use of coal in these areas even by the utilities is very minimal. In the New York area, it's just about nonexistent. We used to import 25 million tons of coal a year into the New York area; that was used primarily by the utilities in the area. That was 25 years ago. Now we import something less than a million tons of coal into this area. And so, again, we have a situation which is atypical when you're thinking of the average which exists in the country. We also have substantial power coming into the region, and this is also true of the whole East, through the grid system that was mentioned yesterday. This eliminates any fuel transportation requirements for this energy since the power comes in through wire in the form of electricity. And, finally, we make a substantial use of natural gas. The use of natural gas was discouraged a couple of years ago, as you know, and the utilities and some industries in the region along the East Coast began to switch away from that fuel. Now, the trend has turned, at least temporarily, and some of the utilities and industries are switching back to natural gas.

Well what does this mean in terms of transportation? First of all, and the only figures I have are for New York so I hope you will excuse my rather parochial view of the situation, we had in the last year some 4,500 tanker movements into and out of the port of New York. These tankers are carrying crude oil for the refineries along the coast of New Jersey. They're carrying large amounts or residual oil, which is used primarily by the utilities in the region, and they're carrying a substantial amount of product, aviation fuel, gasoline, and other types of distillates which are used for various purposes in the region. Now all along the Eastern Seaboard, there are channel limitations which severely restrict the size of tankers used to bring the oil into the region. New York Harbor, and the Hudson River Channel have a 45-foot depth. Most of the other ports are restricted to about 35 feet which keeps the size of tankers down anywhere from 30,000 tons to an exceptional 70,000-ton tanker. This means that we have many more tanker movements than we would need to have if we could handle large supertankers. It also means that the transportation costs of moving the needed petroleum to this region are higher than they would be if the energy were moved in supertankers. And this inevitably leads to suggestions which have been made frequently in the past few years, that we ought to have some kind of a supertanker terminal off the shore of the East Coast cities. This was a very real possibility for a while, in fact, we're still continuing to look at it; but the announced Federal policy of restricting the imports of oil, in fact, cutting down the imports of oil, makes the economics of the very costly construction of a terminal like this rather questionable. So I expect that for the foreseeable future no supertanker terminal will be constructed off the East Coast and whatever oil comes in from overseas, (and this also includes oil that may come by water all the way from Alaska or some coming up from the Gulf) will have to come by small tankers which produce higher transportation costs as well as environmental problems in terms of spillage. The traffic is heavy enough so that we have accidents, groundings, collisions, and there seems to be very little that can be done to improve that situation because of the great economic problems which would be involved in setting up a system where the larger tankers could be used and therefore the movement of tankers could be diminished. Okay, that's the unique situation we have as far as oil is concerned.

Coal, as I said, we use very little. If the President's policy of achieving only a 50% use of oil by the utilities were to be implemented in our area, it would require two things: first of all, we have very high restrictions as to air quality. We have .3 percent sulphur requirements for both oil and coal, which means in effect that we cannot use coal at all since the coal that's available to us from the Appalachian areas where the transportation costs can be managed has a higher sulphur content. Also most of the oil that we must use has to come from the OPEC nations where low sulphur crude oil is available to us. In terms of coal, that sulphur content restriction either has to be changed or there has to be some drastic improvement both technologically and economically in the ability to remove the sulphur from the emissions when the utilities burn higher sulphur coal. The second thing that has to be done is to devise a system of transporting the coal to the region in the volumes that would be required, which would be substantial. As I said before, 25 years ago in the New York area, we used to handle well over 20 million tons of coal a year.

Those facilities, the local facilities, have deteriorated to a point where they cannot handle the volumes that would be required and in terms of the modern methods of moving coal by unit trains. New facilities would have to be built.

There are alternatives. There has been a suggestion called Project ICONN that the way to solve the problem of coal use on the Eastern Coast is to deepen the Erie Canal and widen it so that it could be used efficiently for barge or collier transportation of low sulphur western coal via the Great Lakes down through the Erie Canal to the Atlantic Ocean where it could be distributed up and down the coast. A further part of that would be to use the tremendous amounts of fill that would be developed by such a project to construct about 10 miles off the New York and New Jersey coast, either an "energy island" or what you might call a "dirty industry island," for industries which we have great problems in siting in the urban area there because they don't make good neighbors. This would require an investment of many billions of dollars and it is being talked about but I don't think very seriously so far.

Liquid Natural Gas (LNG) shipments had been regarded as a very excellent means of supplementing the supplies of natural gas that we would use in the region. Natural gas is really a natural for an urban area like ours because of the very low air quality impacts that the use of natural gas enables.

W. BROBST: And no waste island

W. LOVEJOY: That's right. We unfortunately had a fire in a $40 million facility that had just been completed or was about completed on Staten Island for the importation of substantial amounts of LNG. The explosion and the fire were not because of LNG. They were simply cleaning the tanks after construction with the use of a chemical that caught fire and exploded, but it was interpreted by the general populace as being an LNG hazard, Since that time there has been an absolute prohibition of the location of LNG facilities, either on Staten Island or any other place that we could think of for the use of this fuel. So from the transportation standpoint, it looks like the delivery of liquid gas by water is just out as far as the New York area or the whole Eastern Seabord except for Boston which is now getting a certain amount and I don't know how they ever were able to do that but they do it right now.

The final new energy source or augmented energy source could be a buildup of the electric grid that exists over the whole northeastern part of the country. Even there we're running into problems with certain kinds of electrical or electronic emissions from high voltage lines, which are supposed to affect the milk production of cows that are in the nearby vicinity of the lines and disturb television and radio reception and that sort of thing. So here also, we have problems in looking toward a further or more extensive use of this type of energy.

The main impact I think of the transportation problems and in particualr the transportation setup we have for energy along the East Coast is that our energy costs are very much higher than the average for the country. We're the high energy cost part of the U.S. and part of that is distribution problems in very heavily populated urban areas. Part of it is the substantial transportation costs that we have and a question that could be posed is, this something that the Nation should just accept or should there be some effort to even out these costs throughout the country through one means or another rather than having the eastern part of the U.S. which is so populated and has so many people continue to suffer with these high energy costs?

W. BROBST: Thank you Warren. Kathy, how did you ever allow LNG to come into Boston?

K. STEIN HUDSON: Boston was evidently asleep at the switch when the decision was made to bring LNG in. However, there is increasing public concern now about the risk of bringing a bomb like that into a tight harbor like ours.

W. BROBST: What sort of community disruption is likely to exist with LNG in Boston? Aside from peoples' concerns? What effect might it have on other cities?

K. STEIN HUDSON: While I am not a specialist in this area, I can give you my thoughts as a generalist planner. First, there are economic impacts which may, however, be offset substantially by the benefits of bringing LNG in. When one of the tankers moves in our harbor, no other shipping is allowed in the channel and the tankers must move in daylight and clear weather. I don't know what the costs are of other cargoes being stopped, but I suspect it is significant. Flights that might pass over a tanker as they go in and out of Logan airport, which is immediately adjacent to the harbor, also stop. Insurance people and economists are perhaps the best at putting a price on these risks and delays. There are other risks to areas around the harbor. Boston is a very densely populated city with peninsulas that are clustered around the harbor. The downtown is very built up and there are densely populated residential communities around the sides of the harbor. Besides the safety risks to all these areas, I wonder about the extent to which LNG shipment and storage will be a disincentive to future investments in these nearby areas.

How can a price be put on all these risks? What is the cost of blowing up Boston?

There are, as well, some serious issues concerning the transshipment of fuels from the port and on the highway network. We are contemplating putting into a tunnel a major elevated highway that runs through the heart of downtown. One of the issues we're looking at is the cost of disrupting the movement of energy materials. What is the cost of sending fuel trucks around our circumferential highway? How do costs and safety factors weigh against one another? Even though dangerous cargoes are now prohibited from tunnels, is it worth taking the risks of moving those cargoes through tunnels?

W. LOVEJOY: Can I make one comment? The concept of an off-shore island for urban areas where you can handle either the transportation or actually the use of what might be classed as dangerous energy fuels or energy sources may not be eventually so far out of sight either economically or strategically as it appears to be at the present time. You could envision some sort of an island set up 10 to 15 miles off the shore of any of the larger Eastern Seaboard cities where you could perhaps handle the receipt of and the translation of LNG into normal gas that could be piped to the mainland. You possibly could envision that as a site for nuclear plants. You could also use it as a site for picking up oil from supertankers and then finally as we all know the utilities in the north east region are having great difficulty finding sites for either new plants to replace the old plants, inefficient plants that some of them are now operating. Maybe the island could be used for that too so that this is a kind of an intriguing new thought that maybe should be investigated.

H. GAMBLE: Would these be islands or platforms?

W. LOVEJOY: The size that you're talking about they would probably have to be islands.

H. GAMBLE: We were talking about disposal of by-products from coal-fired plants, material that is literally of yellow tooth paste consistency and in vast quantities, In an average sized coal fired plant about a ton a minute is produced and must be disposed of. I saw an article last week where experiments are underway to solidify this and make it into blocks. This experiment, funded by DOE (Department of Energy) will haul the blocks from a power plant in Beaver Valley, PA, which is just west of Pittsburgh, and dump them in the harbor off Fire Island in New York to build reefs.

W. BROBST: They are!

H. GAMBLE: Yes, If you talk about the transportation of energy related materials, this is a by-product of energy generation that must be transported. Produced at the rate of a ton a minute from one plant and consider that we're talking about the increased use of coal, more coal plants, then we can appreciate the transportation logistics associated with that by-product. If it can be used as a base for those islands, then we're solving more than one problem at the same time.

QUESTION/COMMENT: The Island could grow! Like an amoebae.

W. BROBST: One way to handle that is for Congress to have a national LNG commission like the Nuclear Regulatory Commission who, with the way that they function, will prevent LNG plants from being built anywhere.

QUESTION: This solidified material - is that essentially sulphur and sulphur by-products?

H. GAMBLE: And flyash. The coal is ground into a powder before firing so you get none of the larger ash particles as we were familiar with in the old kind of boilers. The ash is all recovered from the flu stacks, it's scrubbed out.

QUESTION: Can this material be used also for building blocks?

H. GAMBLE: I think it has been tried but wasn't successful, It's a tremendous disposal problem.

QUESTION: All of these plants on an island, is this a drawback?

W. BROBST: This also raises questions of costs and benefits and equity tradeoffs of LNG coming into the port of New York or Charleston so that all of this gas can be passed on to people in Georgia and Alabama and elsewhere and why should the people in Charleston accept all of this risk of having this LNG coming into their city when they're not going to be primarily recipients of the benefits from that?

K. STEIN HUDSON: But in Boston that's not true.

W. LOVEJOY: Or New York

K. STEIN HUDSON: Harking back to a comment that Pat Student made in his presentation, I'm struck by the need for greater public awareness of the safety issues, and other impacts, associated with the transport of energy materials. There are three areas in which greater awareness is required. First, awareness is needed on the part of public authorities who regulate or otherwise influence the transportation of energy materials. Second, the general public needs to be more aware of the issues, costs and benefits surrounding the shipment of fuels they use. We need to sort out where the facts lie on safety and cost, particularly to know better what to worry about and not. Finally, there are serious issues for communities immediately adjacent to shipment lines and transfer points. We and they need to be more aware of the special costs they pay and the special risks they are exposed to. With greater awareness in each of these three areas, we will have a better foundation from which the public can support controversial or major actions, as well as to say "no" to them when that is appropriate.

QUESTION: Five hundred people can obliterate or block any accomplishment; my initial reaction is to keep quiet in order to get something done.

K. STEIN HUDSON: The reactions to either keep quiet and act or to work to build public awareness are certainly warring instincts, and there is no neat answer to the question of how one gets the public active.

QUESTION: Is there <u>any</u> answer?

K. STEIN HUDSON: No! No single, neat answer, any more than there is one to the question of how we can keep a handful of private interests from making decisions presumably in the public interest when they are, in fact, not that way. We have heard, for example, of railroads buying out a coal slurry pipeline and the costs and pressures that resulted. There are any number of other examples. It strikes me that in the energy issue, as much as any other one we face, there is a very serious national controversy about who is making the decisions and in whose interest. Who is benefitting? Who is paying the costs? What are the equity implications of those allocation decisions? In what instances do the experts really know best? Am I, as a burner of oil in my furnace and of gas in my car, not competent to go beyond these choices and have a say in much more important, sophisticated decisions? These are critical issues, both when you look at the role of the public and when you look at the role of various private interests in these national decisions.

H. GAMBLE: I'd like to make just a comment in response. I think the adverse public reactions to new energy developments we observe today are in part an outgrowth of the environmental movement. People are much more aware of some of these costs and benefits that are imposed and the inequities stemming from how they're distributed. Some people gain in one location while some people lose in another. Sometimes these costs can be quite substantial. More importantly though, I feel people's anger over energy is an outgrowth of the fact that up until just recently our society and our economy has been developed based on energy that is way underpriced in terms of its true cost to society. Our whole way of living is geared to cheap energy; but we have not paid the real cost of that energy consumption to the world, to society at large, let alone recognized any distinct aspect of these costs. The people in Appalachia are starting to see such inequities, and saying! "Hey, wait a minute. I'll be darned if I want a coal-wash facility in the middle of my town!" Bigler, Pennsylvania, in Clearfield County blocked the

Bradford Coal Co. this past winter from putting in a multi million dollar coal wash facility. The company had a 10 year contract pending for about $250 million of metallurgical coal for South America. A handful of people blocked the issuance of a permit for the plant until they could come up and redesign the plant so as to eliminate some of the environmental effects. I think this is good. Those people deserve recognition. Too many of us think that we can go on and produce energy at the same old price but we can't. We've got to recognize that some of the costs that we were imposing on others by the way we did things simply can't go on. People will no longer remain silent. We've got to pay the piper. If this means and I think in some cases it must mean redistributing income through governmental means, then that may be one of the solutions to these problems. These people want to be rectified for some of the ills they are forced to bear. If you want to look at it crassly, you can bribe or buy them off to stop their protests, Isn't this really the same as compensating them for the environmental degradation they must endure? It all depends upon the perspective one has.

COMMENT: There is no way to compensate for an elk herd. At some time we have to move ahead.

W. BROBST: But can Congress, this Government, make the hard decisions (e.g., on gasohol)?

QUESTION: How do you trade-off decisions made on a parochial basis, in the big picture? How much local autonomy should there be?

H. GAMBLE: The decisions will be made.

QUESTION: W. Lovejoy suggested New York might need help because they have high energy costs. This regionalism is troubling. Does the panel have thoughts on this?

W. LOVEJOY: I think we all have a kind of schizophrenic point of view where we know that we have our own unique regional problems and yet we can all see the need for getting something done. And you even have that problem within regions. Con Edison Electric Co., for example, are being castigated for the fact that they allowed us to have brownouts and they don't have the ability to produce all the electricity they should; and yet when they try to find a place to put a plant, a few people can stop them because it affects their way of life or their well-being. But somewhere there is a point where the individual's complete interests have to be sacrificed to the good of either those in the region or those in the country.

K. STEIN HUDSON: I think there are clear inequities among regions of the nation on the energy supply - demand question. New England and Boston gobble up much more than their fair share of energy, at the expense of much spoiling of states where those energy materials are found and from which they are transported. However, just as we have expanded our look at transportation in the last decade to include social, economic and environmental impacts as well as transport-primary ones, we need to look at the ways regions have deficits and credits in other areas besides energy. For example, the Boston region is the great exporter, the great provider of medical expertise to this country and the world. Citizens all over the country benefit from what my region gives to them while it gobbles up more than its fair share of energy. We do this in the arts, and we do it in education; we do it in parts of the electronics industry. We are certainly gobbling up more than our fair share in other areas besides energy, as well. This illustration points up the broad perspective that I think is required; otherwise, we will end up looking at each single resource, each issue and saying "give me mine first." That won't help us get anywhere.

W. LOVEJOY: This is an extension of the economic concept of specialization that we all accept. either on an international or a national scale. Every region can't be self-sufficient and shouldn't be. The problem is, how do you reconcile that with the individual interests in each region?

H. GAMBLE: With a change in the relative price of energy, that is, energy going up significantly in price relative to the costs of other goods, we might see some change. The change will not be drastic and it might take quite awhile, but there might be some changes in the production of certain goods in regions that tended to specialize. Some regions may become a little more independent; not completely independent, of course, that would be impossible, I'm referring to a very interesting study conducted at the University of Massachusetts recently called the METLAND study in which they examined the requirements for local production versus production in specialized regions for several different items. For example, to produce a gallon of milk in northern Massachusetts required 70% less energy than to produce a gallon of milk in Wisconsin and ship it to the consumer in Massachusetts. That takes into account the more efficient agricultural technology in Wisconsin. They looked at water and they looked at sand and gravel, and the energy savings are significant. With the price of energy going up so significantly, we could very well see shifts in land use. Agriculture in some form might be competitive once again in some areas. I'm not saying we will see overnight a regrowth of agriculture in New England, but it could come gradually and slowly. We could see some shifting in the interregional specialization of production based on just the pricing of energy.

QUESTION AND COMMENTS: Constitutional rearrangements; we can't wait 20 to 30 years. We have to give these needs priority.

W. BROBST: With that, I close this session and charge each of you to write to your congressman about this need to remedy institutional impediments.

SUMMARY

John W. Jimison, Congressional Research Service
Library of Congress

Ed Margolin said the primary themes the conference has come down to are uncertainty and change. I think that is very aptly put. I hope the uncertainty about the major policy questions and the future can be resolved in the next few years and that the changes can be made acceptable.

I'm with the Congressional Research Service (CRS) and I think it's appropriate to say a word or two about CRS as there are often many people who don't know. It's a branch of the Library of Congress that provides Congress with the information and analytical support that it requests in order to make more enlightened public policy and public law. We answer any questions Congress cares to pose. Our products range from a one-word telephone response to multi-volume, multi-year studies. Some CRS analysts work almost as adjunct staff, briefing members and even going to the floor of the Senate.

We get a lot of interesting questions. The Congressional Research Service, a couple of years ago, was asked to answer one of the weightier questions of all time. It was from a Congressman -- I don't think it was one from Pennsylvania. The question was: what did come first, the chicken or the egg? For those of you who are interested, it was the egg.

My job is to summarize and to try to draw the substance from the two days we have spent. Rather than actually summarizing and trying to recapitulate and rehash what we've all heard, I will try to compare and evaluate and try to draw some common themes from it. The danger in simply summarizing is that something important might be left out.

It reminds me of the story about a very straight-laced minister who had one glaring fault: he always read his sermons word-for-word. He wrote them out in laborious longhand and read them page-for-page in a sort of high sing-song voice that used to drive his congregation up the wall. One of the members of the congregation, after interminable Sundays of this, decided to take matters into his own hands. Just before the service, he saw the sermon on top of the altar, and stole one of the pages in the middle of the sermon. Later, the minister was reading the sermon in his usual fashion. He was talking about the creation of Adam and Eve in the Garden of Eden:

"Well Adam was certain to have been delighted and pleased at his new companion Eve, created from his rib, and standing there before him that morning in the Garden of Eden in all her glory," he read. "Eve for her part must have been equally excited. Adam said to Eve, "the Lord has worked a great wonder in creating you to be my woman'. Eve then said to Adam ".. and the minister turned the page ..." ....hmm, excuse me there seems to be a leaf missing".

Rather than have any leaves missing I'm going to focus on the themes at our conference and not try to rehash what the speakers have presented. Looking over the program, one can see it was a very well crafted program. I don't say that having been one of the people who crafted it because we all rode on the coattails of Ed Margolin. Ed is the guru of this policy area. He was lucky to have two very capable expeditors at TRB: Floyd Thiel and Ed Ward.

I think the program essentially revealed the nexus between two public policy areas. These are areas where we're really very much in a dilemma, facing in each of them a great deal of uncertainty and a great deal of change. These are the basic area of energy policy and the area of transportation policy.

There is a great overlap between energy policy and transportation policy that has really gone much too little observed. Very little study has been focused on it. There are two links. One is the energy used by transportation. The other is the transportation used by energy. At first blush everyone is aware of the energy used by transportation because it's obvious to you every time you go by a gas pump. It's a major factor of everyone's daily life.

The flip side of this connection between these major public policy issue areas is less well recognized. The transportation used by energy is so obvious. In fact, when you think about it, energy is probably transportation's major customer or major commodity. Essentially all pipeline transportation is directed to carrying energy, and all electric transmission. The majority of the traffic on the waterways is dedicated to carrying energy. I think Al Johnson said 60 percent was coal and petroleum in one form or another. The major commodity carried on the railroad system is an energy commodity. While trucks are perhaps the least dependent of the modes on carrying energy, still without those that do the whole system would shut down. On truck movement of energy depends the final distribution of all petroleum products. Trucks provide major assistance in the coal cycle and nuclear cycle as well as even some natural gas carriage. So the transportation of energy is as strong a factor in the overlap between the two issue areas as is the energy required by transportation.

We have considered these two major themes at this Conference. Congressman Schuster provided the overall perspective on it from a transportation point of view. What does a person who has studied transportation say about energy? Then Mario Cardullo followed up a little later: What does a person who has been involved in energy say about transportation? We then looked at it from a modal point of view, and I think we learned from several excellent speakers that each of the modes has its role, has its problems, and has its promise. We learned that there is major room for new study and investigation, as Bruce Allen spelled out later. Then the program shifted again to the future fuels for transportation, because transportation is a liquid-fuel consumer, by and large. We looked at oil from shale, from synfuels, gasahol, and learned that these fuels are going to have to be brought on to make the future transportation demands that are considered to be necessary possible to meet.

I thought that one of the things that I might contribute would be an attempt to define the energy problem. I've been involved in looking at the transportation of energy commodities but almost nothing else in the transportation field. I have, however, been studying energy for about 10 years at this point. I think it helps to try to get an idea of what the problem is.

The problem is that there isn't a problem. The problem is that there are four problems with a "twist". I'll tell you what the four problems are, and then I'll tell you what the "twist" is.

The first problem is coping with the economic role of energy in the United States. This problem is that energy is a vital ingredient to the economy and having cheap energy has been a major reason the economy has reached the height that it has. The threat that that energy will no longer be cheap is a threat to the economy.

The second problem is the obvious one of dependence on foreign sources and vulnerability for our

sources of energy. Half of our oil comes from countries over which we have very little leverage and they have enormous leverage over us. They're begining to exercise it and it's beginning to hurt very badly. We're scrambling for ways out of it and we don't see too many. So we have this great political vulnerability and that's a different problem from the one seen from a strict economic perspective.

A third one is the problem of the depletion of oil and gas. The most heavily used and easily developed of our energy resources. We all know that we're "over the hump" on both of those fuels for domestic production. I think it was two weeks ago that an oil company representative said in testimony that he didn't think there was a price for domestic crude oil that would lead us to produce more than we had historically, that we had simply reached the point of declining production and it was going to continue that way. So we have that problem to adjust to and, again, a different problem than either the economic or vulnerability problems.

The fourth energy problem is the problem of social costs, the environmental cost of production and use, the safety aspects, the impacts on society as a whole and on individual lifestyles. A lot of people see the energy crisis as a threat of greater pollution, greater danger and disease, and change of lifestyle for the worse.

These are the four problems: the economics, import vulnerability, the oil and gas depletion, and the social costs. Now I mentioned that there's a "twist". Well the "twist" is that whatever you do to solve any one of those problems will make the others worse. That is really the nub of our energy crisis.

Let me give you some examples. If you work to keep energy cheap for the sake of the economy, then where do you get the energy from? Well since our domestic sources are nore expensive you increase imports. Since you're keeping it cheap you create heavy demand and you increase the rate of depletion. What are you doing to the environment? Well, you make it easier to continue the waste and make it sooner that we'll have to go to dirtier and more damaging kinds of fuels. You're precluding the payment of the full cost of using and finding energy that tends to damage the environment.

Now let's consider what happens if you focus on the second problem, import dependence. By limiting import dependence you increase the depletion of domestic resources. Limiting import dependence by reducing imports forces you to require the use of domestic resources whatever their environmental impacts. You make yourself bite the bullet of having the impacts here rather than overseas where the energy is being produced that you could be bringing in. Import vulnerability may improve, but economics, depletion, and environmental costs get worse.

Oil and gas depletion is the third problem. Obviously, if you hold down oil and gas depletion to try to avoid the "drain-America-first syndroms", you have to import more, increasing dependence. The price of domestic energy goes up and hurts the economy. The alternative fuels to oil and gas which you are saving are likely to be more damaging to the environment.

Finally, if you focus on having no impacts on the environment and on minimizing the social costs and disruption of the enfrastructure of society, then you have to assign those costs some place and they go on higher costs for energy, on more imports and on more rapid depletion of the sources we're using now where the incremental environmental problem isn't too great.

While that may be a complicated definition of the energy problem, I think that if you look at it from the four perspectives in that way, you will find each of them a valid definition of a national policy problem. You will also find that actions designed to cure each of them makes the other problems worse. Then you will also begin to understand why,for example,the Congress has not identified any one of them and said "this is the problem, not the others."

When I looked at the transportation situation, from my own limited understanding of it, and wondered whether it would fit sort of the same kind of definition. I think there are some similarities that it would be worthwhile to evaluate. The economic role of transportation is very simple. This country has depended on inexpensive transportation; it's a very critical input to all economic services and processes. The policy of the government, as in energy, for decades has been to support inexpensive transportation, subsidize it and promote it, and to make sure that it was there to allow the development of our economy. Every bit as much as the inexpensive energy that we've been able to enjoy, the excellent and inexpensive transportation system we've been able to enjoy has brought us to where we are.

I think, second, that there's a dependence side of transportation as well. It's not dependence on overseas nations and political vulnerability. I think there's a modal dependence that has been built up over the years and is a logical consequence of the inexpensiveness of transportation, in the same way that oil import dependence is derived from inexpensive foreign oil. For moving people, we are dependent on the automobile. Since transportation by automobile has been so inexpensive, perhaps dependence on the automobile is more than it would have been without the subsidies and the public expenditures that have been made supporting the automobile. It's clear that there's a modal dependence on the railroads for coal movement at this point and I think it may have been that government policies preserved that more than might have been the case otherwise in a purely free market. I think there's a modal dependence on pipelines for oil and gas. Who knows what alternatives there might have been, but there have been policies in both regulation and in land use that have made it very easy to use oil and gas pipelines.

The depletion problem in energy may be analagous to the deterioration of key transportation systems, and the greater costs of constructing and maintaining waterways, railroad rights-of-way, highways and pipelines. As in energy, what was inexpensive in transportation is no longer inexpensive, even while our need for current systems in good repair is compounded by our need for new systems.

I do not claim that this analysis can be followed to the logical extreme without inconsistencies, or that energy and transportation are twin policy areas. That would obviously be too glib. I am merely suggesting that there are intriguing parallels, and that actions in both policy areas are complicated by having unhelpful consequences. Finally, I think the social costs aspect of the transportation situation are also analagous. There is a preference perhaps to using existing modes rather than constructing new modes. There is opposition to new systems from people who have not had a major facility running through their own areas. The environ-

mental aspects of transportation investments are focussed on.

Since the four energy problems have analogs in the transportation policy area, you might ask about the "twist": whether in fact actions taken to solve the transportation dilemma looked at in one way might not worsen the others. If you address the first problem, you make the attempt to keep transportation inexpensive. You can only do this by restricting a carrier's ability to charge a full market price for the service, a price that accounts for all the costs involved. You continue subsidies, and thus you perpetuate the modal dependencies. You keep people in their cars. You don't build the mass transit because that is expensive. Systems cannot generate the revenue to renew themselves, increasing the deteriotation. Also, you eventually worsen your social cost situation because change is coming however you try to disguise it economically.

If you attempt to reduce the dependence on given modes, attacking the second problem, you find it is very expensive and quickly affects the role of cheap transportation in the economy. We're talking about billions of dollars of investment in new modal capacity and new transportation. That cost has to be borne and it's going to have to be borne by the user of transportation. It's going to have a very strong impact on the economic role that transportation has played to this point in this country. In the same way that the energy crisis that we are facing will have a very major impact on economic activities that we undertake and on our lifestyles, so will the resolution of transportation problems.

The analogy continues to work: working on upgrading and replacing transportation capability conflicts with the desire to keep transportation cheap because it is so costly; it perpetuates existing modal dependencies, and puts off the day of reckoning when no amount of repair and maintenance of all systems will satisfy the needs that have been incurred.

Finally, focusing on mitigating the environmental costs and wrenching change of new systems will lead us to make them more expensive even as we continue dependence on older systems and require more investment to keep them operating.

What we need to do now is to begin examining the similarities that have been brought out in the conference, so that we can stop thinking about energy and transportation as separate areas and start thinking about them as major policy areas with a very significant overlap. We can perhaps deal with our problems constructively when considering a given approach if we consider both the energy consequences and the transportation consequences. It may shape our decisions. It may shape our approaches and it may mean that we avoid worsening a transportation dilemma by improving an energy one or vice versa.

What are some of the themes we have all talked about and listened to that I think are susceptible to that kind of approach? Certainly the economic one is one. The only thing certain about the future of energy and transportation is that they will both be greatly changed in economics. They'll both be a lot more expensive, and I certainly think that the transportation of fuels may lead the way. If we just absolutely refuse to let the prices of fuel and transportation change by means of restrictive regulation, refuse to allow the full cost to be paid, or assign the cost to other things, we build a distortion into the market for energy and for transportation that only worsens our situation. Such a distortion creates its own constituencies like the individual we heard about in the little town in Pennsylvania who kept the train running by himself by protesting every suggested service drop. That's the kind of thing I'm talking about. That kind of distortion and that kind of constituency can be built up if you attempt to suppress the natural free market meshing of the supply and demand for both of the commodities and the price that results.

However, adjusting to the higher prices is a very painful process for an economy with the inertia that we have. Remember that we've built a huge societal machine that used oil and the oil we built that machine to use cost us only about $2 a barrel. We're now facing $20 a barrel oil and synfuels and the rest. The painful thing to remember is that, expensive as it is, OPEC oil is the cheapest energy around that we can use for what we need energy for. Otherwise, we'd be using something else, wouldn't we? We have to have that OPEC oil or we have to make a decision that we're going to pay more for the energy we will have than we're paying for OPEC oil. Synfuels, gasahol, oil shale -- they are all more expensive than OPEC oil. By making a decision to get away from import dependence on OPEC we're simultaneously making a decision that we're going to pay more for our energy than the rest of the world.

The other thing is that if we succeed and actually do create enough synfuels and gasahol to limit our own OPEC imports and to substantially reduce them, what do we do? We effectively put a ceiling on OPEC oil that the rest of the world will benefit from as much as we do. We'll pay the cost of the synfuels establishment, the cost of the gasahol plants and we'll have all that investment and we'll reduce our imports, and those who still buy OPEC will benefit from our investment.

The capital requirements are obviously very major in both cases. The overall approach to money markets that is going to be necessary in the next few years to obtain the $4.2 Trillion we heard yesterday we will need for transportation is going to be something to see. There's just about that much in the money market. We must remember that a lot of that transportation investment for which you need the $4.2 Trillion is only required if you have the whatever trillion that you need for the energy aspects of your investment, too. Those are not the only economic and national purposes which are going to be very expensive to implement.

I think another interesting thing to note is that those transportation modes for energy which are the most economical for energy movement and often which are the least environmentally damaging are also most capital intensive. They are the least flexible. They can't be rerouted. You don't dig up a pipeline and bury it some place else. The value of a pipeline which is no longer carrying oil and gas is just about zero. It costs you about as much to dig it up as the steel is worth. So there's very little salvage value.

I think a second major area of combined evaluation and a theme that we've all talked about here is the area of government regulation. Regulations are used for a number of purposes. I think perhaps the major one in these two areas has been as a moderator of change to preserve the status quo and to keep fluctuations from landing hard on the backs of people economically. This is a valid role but, again, you run the risk of building in the distortions that we've talked about. When you know that the price of energy and the price of transportation is inexorably going up, to try to preserve the status quo is not doing yourself any service in the long run. Our economy can adjust at a certain rate and to allow those prices to moderate at the maximum so that that adjustment can happen without real trauma is probably the better policy.

Finally, there is the regional and geographic

aspect of both energy and transportation. And again there's a great similarlity. When we're looking at the future for energy supplies we're looking at the tapering off of a major supply area of the traditional Oklahoma - Texas oil and gas producing areas. The Appalachian coal resource area is a major area historically and can become more productive but the new areas for energy are primarily the West and Alaska. There is a great requirement for investment in those areas and in transportation from those areas to make that energy available to us. Those sources do not plug very neatly into our existing transportation capacity. There are very few pipelines from the West. The bulk of our rail transportation capacity is not there. In Alaska as well we're having a great deal of difficulty making the connection. So that while we try to have our overall energy consumption grow and our economic process go on smoothly without great lurches and drops we have to do it by adding areas that are not tied in to our current system and probably by letting capacity in our current system be less than fully utilized. That's a great challenge.

Then, of course, there are the regional aspects. People in the West have a right, a valid reason to be disturbed about what the future of that region is going to be. As you recall, the standard synfuel planning plant is a 50,000 barrel a day plant. When you talk about 2.5 million barrels a day of synfuel, you're talking about 50 of those plants. These are industrial installations of a size that can match any industrial installation you can think of, and they're going to be out there where the coal is to a large extent, and they're going to have enormous impacts on the environment and on the lifestyle of the people who are there. I think it is wrong for people in the West to picture themselves as being "colonized" by the rest of the nation. In fact the lifestyle they enjoy would not be possible without the industrial infrastructure in the East, not to mention the Federal support of water programs and reclamation programs they have had access to over the years. Most Western regional disputes on energy and transportaioon are among Westerners, not between the West and the East. The Federal government has made great investments in the West as well as extracting significant tolls.

So these are a few of the themes that I think can be used to analyze both policy areas where they interface. I think it is incumbent on all of us to try to consider the energy impacts of a transportation problem. How will this impact on our energy supply and situation? Vice versa, energy planners should not proceed willy-nilly on a development of a new fuel or on a major effort to get people to conserve fuel without looking at the transportation effects. Those who advocate energy or transportation options without weighing the impacts on the local governments and the economics of the citizens as well as the institutions involved are going to find that in their solutions to problems they've created bigger problems than they've solved.

In closing, I'd personally like to thank everybody who spoke at this conference because I really thought it was one of the better conferences I ever attended. I would also like to thank you all for the liberty of letting me speak my own mind rather than merely summarizing everything everybody else has already said.

RESEARCH NEEDS IN THE TRANSPORTATION OF ENERGY

W. Bruce Allen, Associate Professor of Regional Science and Transportation, University of Pennsylvania

During the last day and a half, we've heard of a number of problems in the transportation of energy. some problems are short run in nature, while others are long run. Some problems are macro in nature and some are micro. Some problems are capital investment related, whereas others are management control oriented. Some problems are engineering - technology oriented while others are economics oriented. Hopefully, as the result of this conference, we can give a push to some of these ideas and increase their funding possibilities (or alternately learn from others - present and non present at this conference which research ideas are currently being undertaken or have been completed - because the field is so vast and not as well organized as some would like).

In the short run transportation demand is a derived demand. Thus to understand the transportation problems of energy, one has to know the supply locations of energy sources, the demand locations for consumption of energy, the substitutability of one source of the same type of energy for another, the substitutability of one type of energy for another, and the characteristics (physical and economic) of the transportation supply modes.

In the longer run sources of supply not yet opened or discovered can be brought on line. New technologies for using existing energy types can be developed, new types of energy can be developed, existing transport technologies can be built in new markets, and new transportation technologies can come on line.

Thus a major research task is to assess the demand for energy transportation by origin-destination, by energy type, by mode, and by time frame.

The movement of energy materials is subject to both economic and safety regulation. The economic regulation is undertaken by various agencies and varies in degree. Movement by barge is technically regulated by the Interstate Commerce Commission (ICC) but because of the bulk commodity exemption from regulation, oil and coal movement by water is almost always exempt from ICC regulation. Movement by truck is also regulated by the ICC. However, since much of this movement is short haul and within a single state, within commercial zones or is done by private carriage, it is not subject to ICC regulation. Energy movements by rail are regulated by the ICC. Although more freedom from regulation has been granted by the 4R Act, the Administration and many others feel it is not enough and have pressed for more relaxation of ICC regulation of rail. The relaxation to date (and some would say that the intent of less regulation has been frustrated by the ICC) of the 4R Act has led to a market dominance question especially in the case of coal.

Thus a major research question becomes what are the economic regulatory impediments to or economic regulatory protections needed to insure that energy materials move and are developed at the socially optimal level.

Non economic regulation also plays a major role. Safety questions arise when flammable fuels are moved and nuclear wastes are transported. Environmental questions arise from the building of new modes, to the medium used to transport (water for slurries), to the operation of the mode (noise, air pollution), and community disruption (unit trains). These problems can be handled by regulatory fiat or by allowing the violators of some societal norm to "buy" society's favor - presumably using the payment to purchase something to abate the social bad caused by the event.

A major research task would thus be to investigate the economic cost of non economic regulations. Knowing such costs would presumably enable society to determine whether it would be worth the price to save the snail darter or preserve the water table levels in Wyoming or the cost of maintaining the Jones Act, etc.

Social investment plays a major role in transportation, especially waterway and highway improvements. Transportation of energy materials occurs on existing social capital and new social capital may be necessary to move new sources, new fuels, or for new modes. Should such new areas and traffic be accommodated? What is the cost of accommodating such traffic? Should the users that impose the spending of social capital be made to pay the costs of such investments in terms of user fees? Such a payment process, recently introduced on the waterways (albeit at a level much too low) and already implemented on the highways (at likely too low a level), if at the appropriate level, will make the consumers of energy pay the increased resource costs required to serve their demands for energy (or adjust their energy consumption or consumption of goods which use energy accordingly). If society pays the capital and operating costs of transportation investment, then heavy users of energy are likely subsidized by lighter users of energy.

Thus an appropriate research task is an investigation of the appropriate funding base for transporting energy materials.

Safety regulation is certainly a non economic regulation and its discussion could be assumed in the discussion above. But is is so important that it deserves some special treatment. Specific items are: tanker safety - to crew and environment, cost of double bottoms, superport development; nuclear shipments - prime and wastes; movements of pressurized gases by all modes.

Safety also relates to protecting the integrity of the product shipped. Which modes are less likely to spill (lose) the product? Which modes are most immune to disaster, sabotage, etc?

Both a macro and a micro study of optimal modal investment are needed. On a macro basis this relates to such questions as rail versus slurry pipelines. On a macro basis it relates to keeping branch lines open versus highway improvements. A Senaca(1) type of analysis on lowest resource costs is necessary with externalities internalized.

The interdependence between modes is also important. Because of economies of density shown by Harris,(2) the possibility exists that diversion of energy traffic from rail, may impose higher costs on other rail users. Likewise, the inability of rail to win new energy transportation (artifically - through regulatory restrictions) may mean that shippers are deprived of these economies of density. This interdependence needs to be investigated through a Seneca type of analysis.

ute the costs and benefits associated with moving coal from mine to consumer and the disposition of the waste by-products from coal power generation.

[1]Senaca, Rosalind, "Inherent Advantage, Costs, and Resource Allocation in the Transportation Industry", American Economic Review, December, 1973, PP945-956.

[2]Harris, Robert, "The Economics of Traffic Density in the Rail Freight Industry," The Bell Journal of Economics, Vol. 8, #2, 1977.

Research Needs From Conference

1. Impact of relaxed environmental controls; who benefits, who bears the costs; how can those who benefit compensate those who lose?

2. Nuclear safety issue - Who pays for what level of safety?

3. Problems caused by unit trains

4. How will the President's speech impact transportation of energy? A. Shuster - not much. B. Cardullo - a lot.

5. Where is the money for all the new rail investment to come from? Other modes have a trust fund. Even if other modes have user charges, are they the appropriate ones - reflecting property taxes, government subsidy of motor carrier risk?

6. Coal train dynamics - first 50 cars create a dynamic effect and second 50 pound

7. How to compensate the states who bear the costs but have neither the origin or destination. 1. How can the gainers compensate the losers efficiently?

8. How can ultimate receiving end of coal shipped be brought up to speed to jibe with origin facilities especially on the lakes?

9. Since existing infrastructure is being built by utilities, how do we avoid the A-J over-capitalization effect?

10. Will there be sufficient crude to run a West to East pipeline after absorption by West Coast refineries?

11. What are the true economics of Great Lakes winter navigation and lock expansion?

12. What would be benefits of reorienting northbound coal southbound? CSX merger.

13. How can institutional problems be solved with respect to utilities? Now stockholders, customers, state commissions, FERC tend to view local problems rather than looking at the big picture - sub-optimum vs. global optimum.

14. Constitutional issues of authority of feds over states in many of these issues.

15. What change in distribution will occur due to President's plan? 1. Ports, syncrudes, markets, pipelines. 2. Despite Ed Bentz's NTPSC studies.

16. What are the unintended effects of synfuels? 1. Highway taxes lost: impacts building program 2. Diversion of land from prime purpose/impact on prices of prime and by-product markets - systems impacts.

17. Truck size and weight issues. 1. Impact of coal trucks on maintenance and building standards 2. How to enforce, collect users taxes, incidence?

18. If the end use products of energy shift, will change distribution patterns. 1. But need to know sensitivity of models to assumptions, growth rates, not meeting standards, etc. 2. How will market areas change?

19. Oil shale extraction technology

20. Is raw shale oil pipelineable?

21. What would impact be on pipeline system capacity of shale oil development? 1. What type of rail and truck interim transportation would be necessary (optimal) if these are temporary modes until you get pipeline volumes?

22. Need transportation plans of inputs/outputs for shale areas of Wyoming, Utah, Colorado.

23. What to do with waste generated by the various new methods - shale, coal scrubbings, gasahol? 1. Cost, location, transportation.

24. Where should site of alcohol distillery be? Where should it be mixed with gas? What is the possibility for in-transit mixing (using transportation as a more productive part of the production process)?

25. What is the potential of forest products as energy producers - impact on transportation and other forest markets?

26. What type of reporting systems should be devised for hazardous materials, how should it be assessed, what should it contain, how could compliance be enforced, what would it cost? 1. What are true benefits of this and cost effectiveness?

27. Cost effectiveness of compliance of truck enforcement of hazardous, truck size and weight, etc., regulations.

28. What is cost of not moving some materials as the result of moving energy materials, e.g., LNG tie up in Boston?

29. Rise analysis and uncertainty. Do we look at expected value or should the results be weighted somehow? Expected value can be the same but variance of probability distribution can be vastly different.

30. What is a cost effective way to increase the awareness of public authorities and the general public?

31. How are the institutional problems solved? How do we handle the constitutional right to dissent? This is a compensation problem in most cases.

32. What are the costs of not following the law of comparative advantage with respect to energy (what are the implied costs of more energy self sufficiency)?

33. What are the costs of making mistakes?

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