

[Misc. publ. **D** **II**]

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DEREGULATION OF NATURAL GAS:

THE PROS AND CONS , 1975.

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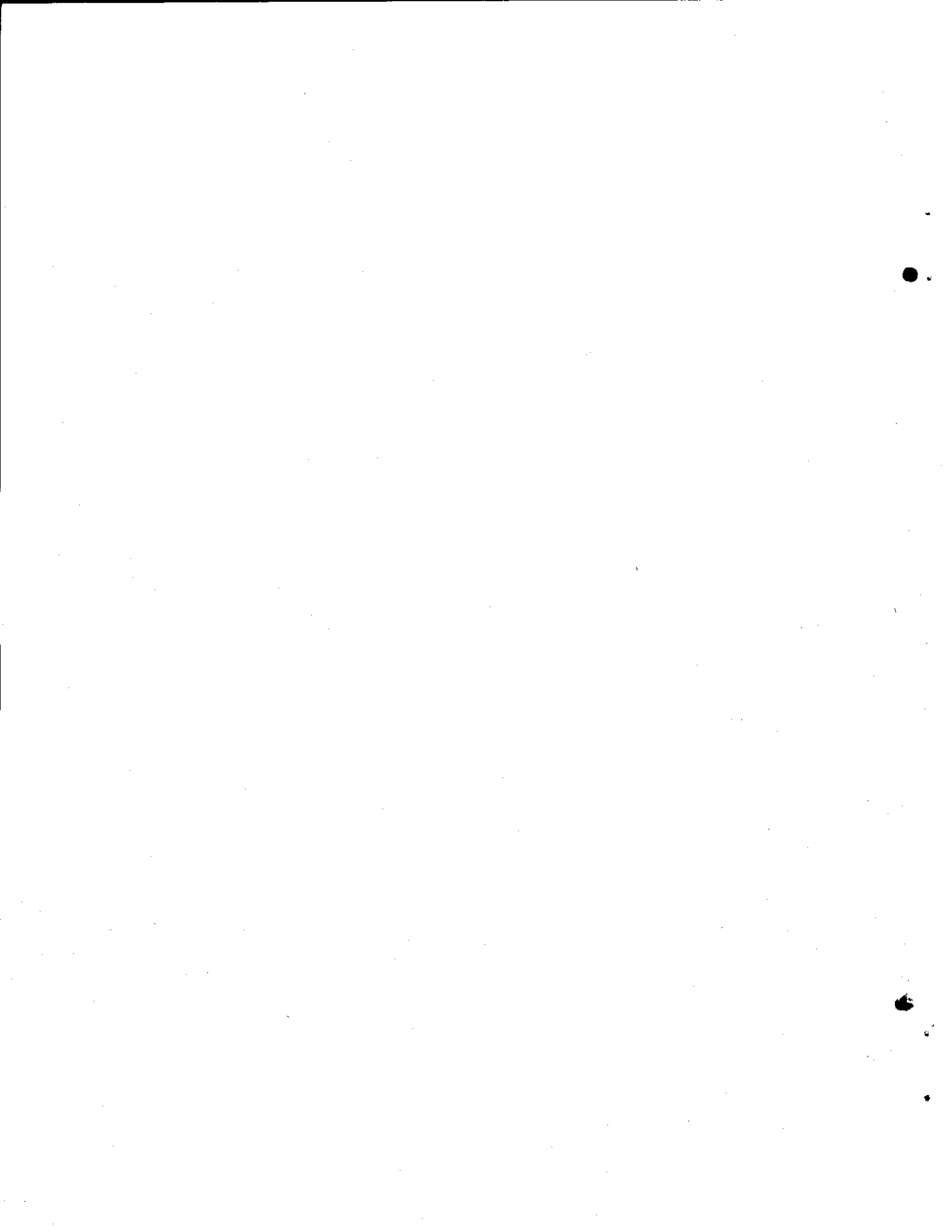
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July 7, 1975

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INTRODUCTION

One of the most controversial issues confronting the 94th Congress is whether regulation of producers of natural gas by the Federal Power Commission should continue. In 1954, the Supreme Court ruled Phillips v. Wisconsin^{1/} that producers of natural gas were natural gas companies within the meaning of the Natural Gas Act of 1938 and were thus subject to regulation in the public interest by the Federal Power Commission. Even before that decision,^{2/} Congress was considering the merits of such regulation. The controversy has gained enormous impetus from a current and severe shortage of natural gas.^{3/}

Natural gas is the major domestically produced fuel. Of 61.6 quadrillion Btus of energy produced from domestic sources, natural gas provided 22.8 in 1973. Domestic petroleum production accounted for 21.6 quadrillion Btus (imports of oil were 13.1 Q Btu).

21.3 trillion cubic feet of natural gas were produced during 1974, 6% less than during 1973, marking the first absolute decline in production since records have been kept. According to the American Gas Association, 8.5 trillion cubic feet were added to reserves in 1974, replacing only 40%

^{1/} 347 U.S. 672

^{2/} President Truman vetoed one bill which would have clarified the Natural Gas Act to exclude producers in 1950. For an excellent narrative summary of the early debates over producer regulation, see Nash, Gerald D.: United States Oil Policy 1890-1964; University of Pittsburgh Press; 1968; at pp. 209237.

^{3/} The parameters of the shortage are clearly spelled out in a staff report of the FPC's Bureau of National Gas, "A Realistic View of U.S. Natural Gas Supply", reprinted in Appendix A.

of the amount extracted from reserves. Since November 1970, interstate pipelines have been required to reduce deliveries to firm customers by 4.5 trillion cubic feet, 686 billion cubic feet of which was curtailed in the first three months of 1975. The FPC now projects next year's curtailments to be 45% greater than this year's.

There is general agreement that whatever action Congress may take on deregulation of natural gas producers, the natural gas shortage will continue and worsen for at least three years. Based upon the end-uses to which the gas is put, the Federal Power Commission has established a priority system for gas deliveries during the shortage.

This paper poses key questions which highlight the major issues in the debate over deregulation, and presents answers to them which might be given both by those who favor deregulation of natural gas producers and by those who favor continuation of FPC controls. It is not intended as an exhaustive treatment of the arguments pro and con, but as a summary. The citations and the bibliography and appendices at the end should be used to supplement the text where more detail or refinement is required. Finally, issues not figuring in the current debate are discussed, and a bibliography of recent materials on natural gas questions is included, along with other appendices.

I. DID THE REGULATION OF NATURAL GAS PRODUCERS BY THE FEDERAL POWER COMMISSION CAUSE THE NATURAL GAS SHORTAGE?

PRO (Those favoring deregulation)

Yes. The natural gas shortage was the inevitable result of the imposition of price controls using public utility regulatory methodology on an industry characterized by great risk. The natural gas prices set by the Federal Power Commission have been maintained for twenty years at levels which were and are too low to elicit sufficient investment from the natural gas producing industry to maintain adequate reserve levels, and which simultaneously stimulated heavy demand for this fuel that quickly took up available supplies.

Although it has experimented with several methods of setting gas rates, the FPC has consistently tied the final price to evidence of the cost of producing natural gas. Prior to 1960, the FPC attempted to assess each producing company's cost and investment, but this was found unworkable both because it was impossible accurately to assign joint costs between the gas and the oil that the same company produced, frequently from the same well, and because such a procedure was so time consuming that literally decades would be required merely to set initial rates for the entire producing industry. Since 1960, the FPC has attempted to determine average costs incurred by producers in geographical areas. Here also the problem of joint cost allocation between oil and gas confronted the FPC, and the proceedings required such amounts of evidence and testimony that years were required to reach a certain result.

Even if costs were precisely and quickly determinable, however, regulation based on costs would fail. This is because the costs for producing

natural gas vary so greatly from well to well, from one company to another, and from place to place within generalized producing areas, and because the cost of a given project has no relation to the amount of natural gas that can be expected to result. When prices are set based on the average cost of one company or many, only those projects actually costing that average amount or less are profitable. Hence, only low-cost efforts are attempted; riskier prospects are ignored.

The effect of cost-based regulation by the FPC has been a declining exploratory program, which has led to fewer and smaller discoveries of natural gas, failure to replace the natural gas produced each year, and the current shortage.

At the same time, FPC regulation held natural gas prices to artificial levels well below those of alternate fuels, naturally encouraging new and old users to consume natural gas if it could be obtained. Major consumption of gas for relatively inefficient purposes such as electric generation resulted. The demand created by the low prices for gas cannot now be satisfied with the small reserves prompted by the low prices, and widespread and deep curtailments of service have resulted.

The list of expert independent economists who espouse the view that FPC regulation caused the shortage is too lengthy to report, and they are joined in their beliefs by a number of highly respected newspapers, and, not least, by the Federal Power Commission itself. The FPC has tried for several years, despite difficult procedural and judicial obstacles, to do what probably cannot be done: to provide suitable incentives for natural gas producers within the framework of the existing Natural Gas Act.

Warnings that a shortage of natural gas would be the inevitable result of FPC controls have been voiced throughout the years since the Phillips decision, but the Congress and the rest of the nation has been content to ignore the perennial decline of the ratio of reserves to annual production and other indices of an imminent shortage as long as there was enough for the next year. Now there will not be enough for next year. The reason is FPC regulation, and the solution is its removal.

CON (Those opposing deregulation)

No. The natural gas shortage was not caused by the FPC's efforts to regulate gas prices, but instead by an explosion of demand for gas deriving from external factors, speculation by producers on uncommitted discoveries of natural gas, and the rapid growth of major gas-consuming markets in proximity to the producing fields.

Far from being depressed by Federal regulation, the natural gas industry has expanded and prospered under it. Both annual production and total reserves increased rapidly until 1974 and 1967, respectively. Even in gas well drilling, where so-called artificially low prices would have been expected to have had their greatest effect, the trend shown in the accompanying FPC graph has not been as bleak as it had been for oil, which was not regulated until 1972, and which has always been several times the price of gas per Btu.

Nor were the prices set by the FPC unduly low. Econometric modeling by advocates of deregulation has suggested that the uncontrolled price of natural gas between 1960 and 1968 would have averaged about 23.8 cents per Mcf (thousand cubic feet) rather than the actual regulated average

of about 17 1/2 cents.^{4/} If this is accurate, the contention of those who would deregulate is apparently that demand for natural gas which arose because gas was sold at a price equivalent to oil at \$1.01 per barrel would have been deterred had natural gas been marketed at a price equal to oil at \$1.38, while supply efforts would have been adequate. We doubt this.

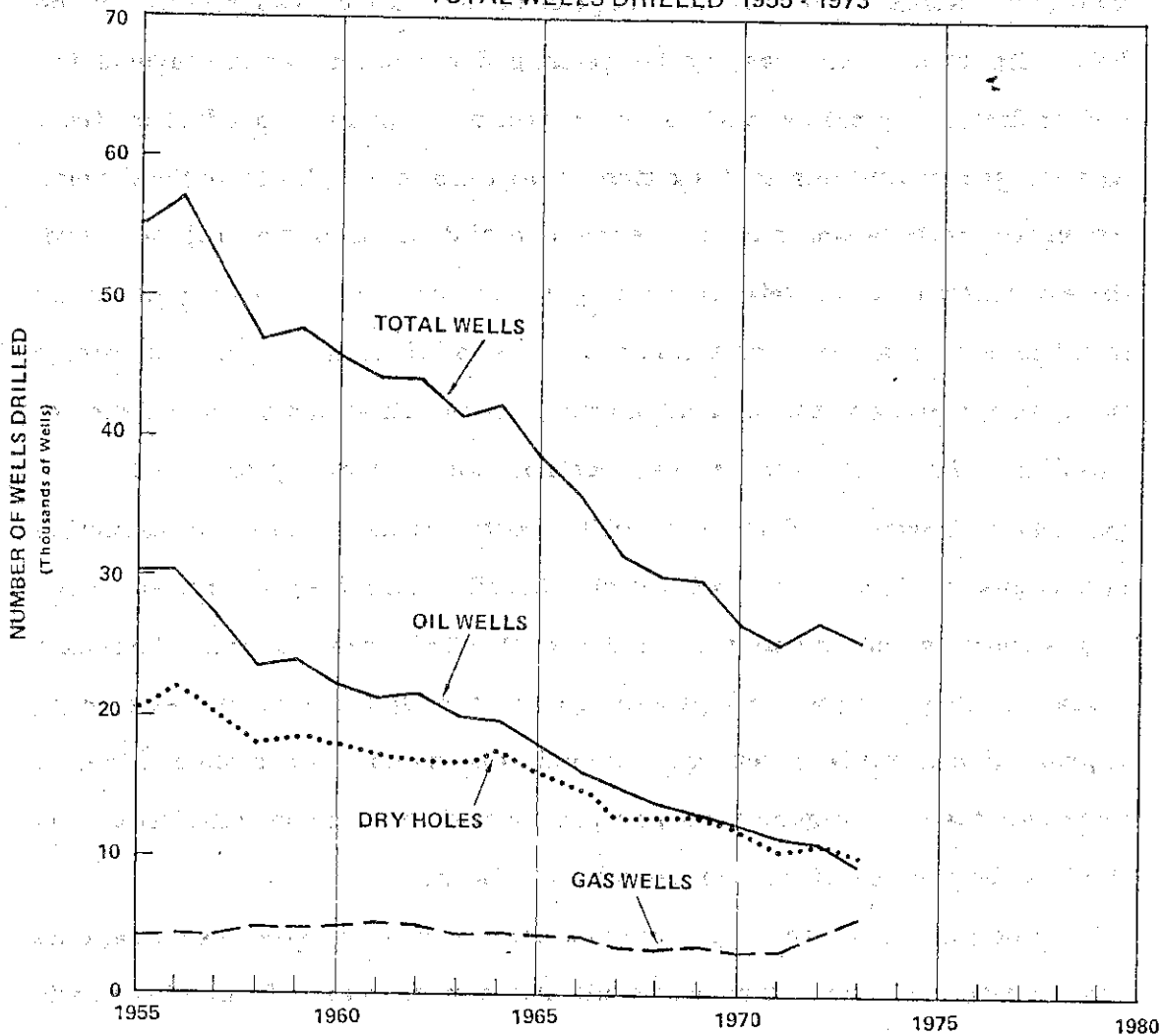
In fact, producers of natural gas themselves stipulated that 26 cents per Mcf would be an adequate price for natural gas to stimulate sufficient additional production in the major producing area of the country in 1971, and stated that they would accept only 1 cent per year annual escalations in this rate through 1976.^{5/} The FPC took the gas producing industry at its word and granted the rate settlement requested, but additions to reserves have continually fallen in that and all other areas. The same producers now condemn a suggested ceiling price of 75 cents per Mcf as totally inadequate, knowing that gas prices in excess of \$2.00 per Mcf could be obtained in the absence of FPC controls.

4/ Breyer, Stephen and MacAvoy, Paul; The Natural Gas Shortage and the Regulation of Natural Gas Producers; Harvard Law Review 86:941 at p. 975.

5/ Southern Louisiana Area Rate Proceeding, FPC Docket AR69-1, decided July, 1971. The pledge subscribed to virtually every producer respondent in that case was as follows:

Each producer individually represents to the Commission that the ceiling prices and other provisions contained herein provide incentive for the exploration for and development of gas reserves in the Southern Louisiana Area. In view of the nature of producing and finding hydro-carbons, it is unrealistic to expect producing companies to guarantee that the ceiling prices and other provisions contained herein will elicit a specific supply of gas; however, it is believed that the ceiling prices and other provisions contained herein will make funds available to the producing industry and create a regulatory atmosphere which should provide an incentive for a substantial increase in exploratory and developmental activities and make a major contribution to bringing forth additional supplies of gas from the Southern Louisiana Area to meet the demands of all consumers supplied by this area.

CHART V-A
 TOTAL U.S. DRILLING ACTIVITY - OIL, GAS, DRY AND
 TOTAL WELLS DRILLED - 1955 - 1973



OIL AND GAS WELLS											
Yr.	Oil	Gas	Yr.	Oil	Gas	Yr.	Oil	Gas	Yr.	Oil	Gas
55	30,432	4,266	60	22,233	5,129	65	18,065	4,482	70	12,398	3,225
56	30,528	4,531	61	21,413	5,459	66	16,216	4,321	71	11,510	3,399
57	27,364	4,475	62	21,727	5,353	67	15,073	3,602	72	11,139	4,777
58	23,774	5,005	63	20,135	4,570	68	13,982	3,329	73	9,555	5,894
59	24,043	4,931	64	19,905	4,694	69	13,213	3,656	74		79

DRY HOLES AND TOTAL WELLS ^{1/}														
Yr.	Dry	Total	Yr.	Dry	Total	Yr.	Dry	Total	Yr.	Dry	Total	Yr.	Dry	Total
55	20,452	55,150	60	18,185	45,547	65	16,226	38,773	70	11,161	26,784	75		
56	22,111	57,170	61	17,382	44,254	66	15,193	35,730	71	10,448	25,357	76		
57	20,156	51,995	62	17,078	44,158	67	12,958	31,633	72	11,171	27,087	77		
58	18,162	46,941	63	16,762	41,467	68	12,954	30,265	73	10,017	25,466	78		
59	18,589	47,563	64	17,694	42,293	69	13,076	29,945	74			79		

Source: World Oil
^{1/} Excludes service wells.

WELLS DRILLED (Thousand Wells)

FOOTAGE DRILLED (Million Feet)

The shortage of natural gas would have occurred and to approximately the same extent without regulation of natural gas prices by the FPC. Its root cause was the burgeoning demand for gas throughout the United States, combined with the commitment of and full production from natural gas inventories that existed in oil fields throughout the Southwest. Among the factors which led to an explosion of demand for natural gas were: the extension of interstate pipeline systems from major producing areas to all major areas of industrial and residential consumption, completed in the early Sixties; the natural advantages in cleanliness, convenience of handling, flame and temperature control, and constancy of supply of a gaseous fuel purchased under a utility contract; the aggressive marketing campaigns conducted by pipelines and distributors alike; the lower prices of gas-burning equipment; the rapid growth of plastics and petrochemicals industries requiring natural gas for raw material; the lack of fuel storage expense and facilities; general economic expansion; the higher prices of alternate fuels -- higher than gas prices with or without regulation; and the first beginnings of environmental awareness.

Pipelines eager to keep adding customers concentrated less on adding new reserves -- more than a certain number of years of supplies in advance of need was deemed a misallocation of current assets. Oil drilling constantly declined in the face of pressure from cheaper imports, reducing resources of oilwell gas, and the leasing of offshore prospects was slowed by the Department of the Interior. Finally, energy-intensive industries began to locate in producing states to avoid pipeline transportation charges, and the electric utility industry of the Southwest switched to natural gas almost completely. This unregulated intrastate market was soon able to

absorb all the additional production that became available onshore. But even after they were no longer able to acquire new reserves, pipelines and distributors continued to promote gas and seek new customers.

The real function of FPC regulation since the beginning of this decade has been to restrain gas prices from rising by amounts equal to the price rises (about 600%) experienced in unregulated markets. Regulated gas prices have risen at a rate of about 30% per year, and are now at twice the level requested by the industry for 1975 in the 1971 case noted above.

Many have sought to make the FPC the scapegoat for the shortage, but the FPC is not at fault, except to the extent its responses to the shortage encouraged withholding of gas. The effects on the natural gas shortage of lack of competition in the industry and speculation on discovered gas reserves will be discussed in response to other questions. As America careened towards an energy crisis during the 1960's, there is no credible evidence to suggest that removal of FPC regulation would have delayed or prevented the shortage of natural gas.

II. WILL DEREGULATION OF NATURAL GAS PRODUCERS INCREASE NATURAL GAS SUPPLIES ENOUGH TO END THE NATURAL GAS SHORTAGE?

PRO (Those favoring deregulation)

Hopefully. There can be no guarantee of the amount of natural gas that would be discovered and produced. Recent estimates of potentially available natural gas have been more pessimistic than previous estimates. That does not mean that they are necessarily more accurate.^{6/} But even if these new low estimates are correct, there is a substantial amount of gas to be found and produced. It will never be found if finding it is not economically attractive to producers. Hence, although there can be no guarantee that enough gas will be found to end the natural gas shortage, it is guaranteed that without the certainty and incentive of free market pricing, the amount of natural gas found will be much less. We might never know whether or not additional drilling could have ended the shortage unless it is possible for producers to drill the many unexplored prospects that may conceal huge quantities of natural gas. This will not be possible unless the environment within which the producing industry functions reflects the true nature of that industry - price ceilings set by Government regulators cannot be responsive enough to the time and investment constraints faced by the myriad of highly-competitive gas producers to bring forth their best efforts. Only the market mechanism is that flexible.

6/ The recent National Science Foundation study, widely quoted for very low projection of potential oil and gas supplies, has been heavily criticized for ignoring the elaborate and careful work of the Potential Gas Committee, which related its result much more closely to the available data, and determined that potential supplies were more than twice the NFS estimate. Potential Gas Agency, Potential Supply of Natural Gas in the United States (As of December 31, 1972) Colorado School of Mines Foundation, Golden, Colorado, 1973, 48 pp.

In another sense, deregulation will clearly end the gas shortage. As Economist Edward J. Mitchell explains, "A shortage is a policy . . . if we never found another barrel of oil or cubic foot of natural gas, or never mined another ton of coal, there would be not necessity for shortages. This observation follows from the fact that at some price the energy market will clear. As long as either less is demanded or more supplied as price increases, there is some point at which supply equal demands."^{7/} As is more fully spelled out in response to the final question, there is no way that the available natural gas can be allocated to the highest and best purposes without using the market mechanism as the agent of allocation. Nor can the market mechanism function to allocate natural gas from pipelines to consumers if the market mechanism does not govern the sale of gas from producers to pipelines.

Perhaps the best way to look at the situation is to realize that the differing depths, sizes, locations, and other characteristics of natural gas reservoirs naturally makes production from them economic at differing prices. To set a certain regulated price level, as the FPC does, is effectively to say that gas costing more than the level to produce is not needed. Yet it is obvious that the gas is needed, and that, given the liberty, the free market would pay the higher cost necessary to make it economic to be produced. While it may well be that enough gas would not be produced following deregulation to return us to the days of expanding gas sales and lavish uses -- and perhaps we should not reinstitute some of the wasteful consumption we have known -- it is clear that holding the price of

7/ Mitchell, Edward J.; U. S. Energy Policy: A Primer: National Energy Project; American Enterprise Institute. Washington, D.C. 1974. 103 pp. at p. 1.

below the price the market would set creates a greater shortage than would otherwise occur. To that extent at least, deregulation will end the natural gas shortage.

CON (Those opposing deregulation)

No. Deregulation will not end the shortage of natural gas -- it will just make the shortage many times more costly to consumers and enrich the major oil companies which have a hammerlock on existing gas supplies.

Certainly it is true that allowing desperate gas consumers to bid against each other for available amounts of gas would force enough of them to alternate fuels that demand would be clubbed back to the equivalent of available supply. But the expense in terms of higher natural gas prices would be staggering. It is no wonder that producers would love to be getting \$2.00 for the gas they now sell for 30 cents. But even if they were to get \$50.00 per Mcf, they would not drill where they did not think they would find gas. It is not accurate to think of our natural gas resource as an amount which will somehow be more adequate if prices go up. There is a certain amount of natural gas to be found in the United States and when that is found, that's it. The evidence indicates clearly that so much of the existing gas has been found that we can never again expand gas sales, through traditional exploration and development of sedimentary basins.

The U.S. Geological Survey issued on May 7, 1975, a news release revising its previous estimates of available natural gas resources downward to a range 500 to 835 trillion cubic feet. Previous estimates had been as high as 6400 trillion cubic feet. The FPC staff, even before this estimate, had declared that increasing shortages were inevitable^{8/} regardless of the size of the U.S. undiscovered base.^{7/} For the natural gas

^{8/} See Appendix A, p. A-20.

producing industry to present deregulation as an alternative to a continuing gas shortage is fraudulent. Industrial consumers, persuaded to lobby Congress for deregulation so they can avoid curtailments, are being misled. The odds are great that those now being cut off from gas supplies will never be reconnected, and that even after deregulation the higher priority uses will continue getting available gas because they will be able to outbid the lower priority users for it at the superhigh prices which will prevail.

The lack of ability of natural gas producers to provide more gas at the prices which will prevail after deregulation was clearly documented by the Project Independence Blueprint. As can be seen in the accompanying table, the production of natural gas projected to result from a price of 80 cents per Mcf (19.114 Tcf in 1985) is virtually the same as the amount which would result from a price of \$2.00 per Mcf (19.141 Tcf in 1985). The extra cost to consumers of deregulation in 1985 alone will be \$23 billion, assuming that 80 cents was the regulated price level, that deregulated prices were no higher than \$.2.00, and that old gas contracts had all expired.

The history of recent years demonstrates conclusively that deregulation and higher prices are unlikely to elicit increased supplies. The FPC has increased producer's prices an average of 30% per year, far in excess of general inflation, yet reserves additions and commitments have continued to tail off. With each of its many actions, the FPC has found that the price set is the price necessary to stimulate the necessary exploration and development of natural gas to reverse the trend, and each time the FPC has been wrong. Perhaps more to get the monkey off its back than

Total Non-Associated Gas Production Possibilities
Lower 48 States 1/

1974		1977		1980		1985		1988		"Minimum Acceptable Price" of Last Mcf
BAU <u>2/</u>	ACC <u>3/</u>	BAU	ACC	BAU	ACC	BAU	ACC	BAU	ACC	
16.522	16.522	13.132	13.133	9.683	9.683	5.509	5.509	3.812	3.812	\$0.20
16.522	16.522	14.215	14.250	11.793	12.109	6.993	7.219	4.830	4.986	0.30
16.522	16.552	15.222	15.284	13.187	13.652	9.163	9.100	6.630	6.529	0.40
16.550	16.550	15.667	15.767	15.470	16.013	13.388	12.867	9.867	9.465	0.50
16.550	16.550	15.697	15.804	15.653	16.711	15.865	17.030	13.139	13.781	0.60
16.550	16.550	15.919	16.035	16.011	17.023	17.193	18.548	16.099	16.475	0.70
16.550	16.550	15.923	16.040	16.014	17.026	17.349	19.114	17.227	17.866	0.80
16.550	16.550	15.925	16.042	16.012	17.030	17.361	19.116	17.829	18.858	0.90
16.550	16.550	15.925	16.042	16.019	17.033	17.362	19.118	18.011	19.513	1.00
16.550	16.550	15.925	16.042	16.024	17.039	17.366	19.122	18.014	19.683	1.10
16.550	16.550	15.925	16.042	16.025	17.040	17.382	19.141	18.037	19.709	2.00 or more

1/ Volumes in trillions of cubic feet, "prices" in cents per Mcf (constant 1973 dollars).

2/ Business as Usual Scenario.

3/ Accelerated Development Scenario.

Source: Federal Energy Administration, Project Independence Blueprint, Final Task Force Report-- Natural Gas.
Under Direction of Federal Power Commission, November, 1974. p. xii

out of conviction, the FPC now advocates an end to its consumer protection responsibility in this area.

The natural gas which remains to be developed will be developed as long as the price allowed for its is sufficient to cover the costs incurred by the producer who finds it and provides a profit as well. There is no reason to allow the shortage to force consumers to pay prices several times that much for the same amount of natural gas. The prices allowed by the FPC are set on that basis, and producers have had full opportunity to demonstrate to a very sympathetic FPC that the prices resulting have been inadequate. They have been unable to demonstrate by evidence of costs or other evidence that the FPC's gas rates are non-remunerative.

Much of the remaining natural gas resource is located on Federal lands offshore. Deregulation would do nothing to change the rate at which these lands are leased. The Government's revenues from bonuses might well increase as deregulated prices raised the value of the leases, but presumably gas production at current rates is remunerative enough to attract a full scale developmental effort. The producing industry insists that there is no withholding going on because of low prices, and they pay millions for the opportunity to lease choice tracts. (See next question). Deregulation would do nothing to increase production on Federal lands offshore above what it would be without deregulation.

Onshore, there is no effective regulation in the key producing areas because of the ravenous and uncontrolled intrastate markets. Yet despite the increased drilling apparently inspired by record prices, shortages prevail onshore as well. Louisiana's Director of the Department of Conservation noted in testimony before the Senate Commerce Committee that,

"the shortage of Louisiana's intrastate systems is every bit as acute, if not more so, than any of the many interstate pipelines gathering and transporting gas out of the state."^{9/}

If deregulation will not increase the available resource, nor cause more gas to be produced than at regulated prices over the short term, nor increase production offshore or onshore, as the evidence suggests it will not, what will deregulation do to end the shortage? The answer is obvious -- it will raise the price until enough gas users are forced to alternate fuels that the remaining ones can all get gas. This can be done administratively with little trouble and at far less cost to the nation, as is shown below.

The shortage of natural gas is here to stay. A massive transferral of wealth from gas consumers to the oil companies who produce gas will not change that basic fact.

9/ Testimony of Ray T. Sutton, Commissioner, Department of Conservation, State of Louisiana, in Hearings on the Natural Gas Production and Conservation Act of 1975, U.S. Senate Commerce Committee, March 17 & 18, 1975. at p. 205.

III. ARE NATURAL GAS PRODUCERS WITHHOLDING NATURAL GAS, OR SPECULATING ON THE VALUE OF SHUT-IN RESERVES?

PRO (Those favoring deregulation)

Absolutely not. Natural gas producers, while without the incentive to explore for and produce all the natural gas that could be found, are doing their utmost to produce the natural gas that is known. Withholding of natural gas production would be a violation of private leases onshore, and a violation of Federal regulations offshore. No producer would risk losing his entire investment in a lease through a forfeiture for the purpose of delaying sale of natural gas until the price goes up. Indeed, the expenses incurred in bringing a lease to the point of production are so great that no producer could afford to forego the earliest possible return on that investment. Interest and inflation would reduce possible gains from delay in development to almost nothing.

Since this allegation has been raised by those desperate to find something beside Federal regulation to explain a shortage primarily due to Federal regulation, both the FPC and the Department of the Interior have conducted searching investigations of the operations of lessees accused of having shut-in reserves that could be producing. They have found in each case that the leases stated to be withheld are either producing, or not producing for valid reasons. Virtually all of the leases not producing are already committed to contract at a certain price, rendering speculation on deregulation useless.

Often gas is discovered on a offshore lease in quantities too small to justify the cost of building an underwater pipeline to the area. The well is usually

shut-in until sufficient reserves are found to justify the pipeline, or until a pipeline is build nearby to another area. Also, reserves are shut in if they are located above other reserves which are producing from the same well, in accordance with reservoir engineering practice for conservation and maximization of total recovery. Finally, many wells that are shut-in are exploratory wells which were drilled merely to determine the feasibility of production from the lease, and cannot be produced from. Production from such a lease must await the building and installation of an offshore platform, the drilling and completion of production wells, and the connection of a pipeline to shore -- a process requiring many months.

The reserves information question has long plagued the natural gas industry, which has been accused time and time again of understating reserves in order to obtain increased prices, or in order to create an artificial shortage. These allegations are equally preposterous. Since 1946, the natural gas industry has published proven reserves statistics through the auspices of the American Gas Association. An enormous amount of expertise and effort is invested each year to give the nation the best estimate possible of the amount of natural gas producible under current economic and operating circumstances to meet our national needs. These statistics showed over many years a declining trend, clearly indicating the negative impact of Federal regulation. No one questioned them. Suddenly, when the shortage occurred, critics begin arguing that it was an artificial shortage created by the manipulation of the reserves statistics.

Reserves estimation is at best an inexact science, with experts disagreeing by as much of 100% in their estimates of a given field. It is

no wonder that there are discrepancies between different reports. But the trends shown by differing reserves reports have been uniformly pessimistic.

The Federal Power Commission, largely in response to criticisms of industry reserves reports, undertook its own massive study of proven reserves, examining itself a large number of natural gas fields in its National Gas Survey.^{10/} The FPC concluded that there were substantially less reserves than the industry had reported, cutting the heart out of the challenge.* But the issue is almost irrelevant, in any case, because even if the proven reserves were greater than the reported amounts, the amounts added each year are obviously far below the amounts needed to sustain current production, and the massive and growing curtailments by interstate pipelines are eloquent evidence of the natural gas shortage.

It would serve the nation better to devote the energy now spent on disputing the measurement of the shortage to ending it.

CON (Those opposing deregulation)

Yes. There is substantial evidence that producers of natural gas are refraining from production of large amounts of natural gas in order to obtain windfalls from the much higher prices expected after deregulation. Moreover, the FTC has now documented what many have long suspected -- that the reported reserves statistics of the oil and gas industry were deliberately understated in order to achieve higher rates from the FPC and deregulation from Congress.

10/ Federal Power Commission, National Gas Survey, National Gas Reserves Study, Washington, D.C. 1973.

* As this paper was being readied for printing, the FEA also announced the results of a separate study of gas reserves which refutes critics of the AGA estimates.

Natural gas producers have the motive for withholding, the means to withhold, and there is evidence that withholding is occurring. The motive is the possibility of staggering profits if gas found when FPC rates of from 20 cents to 55 cents were in effect is not dedicated to sale until deregulated prices of about \$2.00 are obtained. If a producer withholds production from a gas field of 100 billion cubic feet in reserves, a moderate-sized gas field, rather than committing it at the new gas rates of 55 cents, he can increase his total revenues from the field over 20 years, the average contract length, from \$55 million at FPC rates to \$200 million under deregulation. The possibility of this profit far exceeds the likely inflation until Congress decides on deregulation, or the interest on the investment in the lease and drilling costs. Even under continuing regulation by the FPC, which has raised rates an average of 30% per year, the dollar appreciation of the unproduced reserves exceeds the costs of letting them lie untapped. Moreover, the worse the shortage, the greater the pressure on Congress and the FPC to raise prices.

With this incentive to withhold production, producers also have the means to withhold, because of lax enforcement of production requirements by the U.S. Geological Survey and the easy extension of a producing lease by payment of a nominal "delay rental". A recent survey by the National Aeronautics and Space Administration for the United States Geological Survey found that only about 10% of offshore leases are being produced, but that USGS does not have the personnel to enforce production requirements, or the inclination, after years of merely assuring conservation of resources. Even onshore, if there is no access to deregulated intrastate markets, withholding occurs through payment of small annual charges to landowners.

Although producers claim that they could never afford to sit on such large investments without obtaining the earliest possible return, it should be remembered that the money used for oil and gas drilling is "risk money": money that is used with knowledge that it may be totally lost if dry holes are drilled. It is not money that must be paid back to lenders on a fixed schedule. Having invested funds which they are prepared never to recover or achieve a return on, producers are obviously prepared to forego that return temporarily while speculating that the eventual recovery will be many times the price and profit gained from an immediate sale.

The evidence indicates that the motive and means of withholding are being taken advantage of by the producing industry. A USGS official admitted to one energy publication: "We don't have any reason to believe that oil is being held back. Gas is a different situation. The price of gas is regulated and it is low. I wouldn't make an out-and-out statement that there aren't gas reservoirs that are waiting to produce for a higher price." ^{11/}

The Federal Power Commission reported in 1974 that there are 4.7 trillion cubic feet of proven reserves and 3.3 trillion cubic feet of probable reserves under 168 leases on the offshore continental shelf classified by the USGS as "producible shut-in." ^{12/} A separate FPC study indicated

11/ W.A. Redlinski, Associate Director, quoted in Sege, Irene; US Geological Survey Under Attack; Elements, June, 1975. p. 5

12/ Federal Power Commission, Offshore Investigation: Producible Shut-in Leases. As of January, 1974, (Second Phase) Bureau of Natural Gas, Federal Power Commission, Washington, D. C., July, 1974.

that reserves holding 8.5 trillion cubic feet in 1973 and 9.7 trillion cubic feet in 1974 were not producing any gas although they were dedicated to pipeline systems. ^{13/}

On March 14, 1975, the Department of the Interior, after a spot check of 17 leases, ordered three companies to begin production on three leases or risk losing them for lack of diligence. ^{14/}

The unavailability of comprehensive information about withheld production is symptomatic of the lack of verifiable information of any sort to the Federal Government about reserves of natural gas. Although they are relied on as accurate and plugged directly into the formulas used to set consumer's gas rates, the reports of gas reserve totals from the industry have never been thoroughly validated by the Federal Government. The FPC's National Gas Survey Reserves Study, which actually found less gas than the industry reported, was operated by committees dominated by oil industry employees and estimated the reserves of a sample of leases selected by industry representatives. ^{15/}

There have been a number of investigations indicating that the AGA reserves reports are badly understated. The FPC staff checked the reserves reported for 31 leases from a single 1970 lease sale, and found that

13/ Federal Power Commission; Preliminary Investigation -- Non-Producing Gas Reserves in the Gulf of Mexico; Bureau of Natural Gas, FPC, Washington, D. C. , February, 1975.

14/ Gapay, Les: "Oil Firms to Be Told to Start Output Soon on 3 Federal Gas Leases or Lose Them"; Wall Street Journal, 3/14/75, p. 4

15/ See Hearings of the Special Problems Subcommittee of the House Small Business Committee on Concentration by Competing Raw Fuel Industries in the Energy Market and Its Impact on Small Business, Vol. 3, National Gas Survey and Synthetic Fuel Development. March 16 and 21, 1972.

the actual totals were 54% more than the amounts reported to the AGA for those leases. ^{16/} The most critical investigation of the AGA reserves reports has come from the Staff of the Federal Trade Commission, which since 1970 has been investigating the reporting procedures for evidence of collusive activities. Information that has been released from this investigation has indicated that the reserves estimates employed by producing companies for their own internal purposes has exceeded the amounts reported to AGA by as much as 800% for given leases. Information from this investigation has been released by the Investigations and Oversight Subcommittee of the House Interstate and Foreign Commerce Committee because of the impact it may have on the deregulation debate, despite jeopardy to the prospects of a possible FTC antitrust suit over the alleged improprieties.*

Why would the producing industry deliberately understate proven reserves? One possible rationale may be that the FPC's area rate price-setting methodology uses proven reserves figures along with statistics of finding rates (amount of gas found per foot drilled) as the denominator in the formula used for setting producer rates, with the costs incurred by the industry as the numerator. To the extent the reserves additions are smaller and the finding rate lower, the resulting price goes up. Perhaps by coincidence, the reserves figures began dropping precipitately beginning with the report published the year after the Supreme Court upheld

16/ Federal Power Commission, Notice of Issuance of Revised Staff Nationwide Cost Study and Staff Study of American Gas Association Reserve Additions. Docket R-389-B, March 21, 1974.

*The way recent FEA study supporting the industry reserve totals was based upon questionnaires that aroused great criticism for consumers and which were reviewed by the industry prior to distribution.

this FPC rate methodology, 1968. Perhaps also by coincidence, the finding rate also began falling steadily at about the same time, without reasonable geological explanation, to a fraction of the former levels. As a final "coincidence", the reserves reports by companies to the AGA and the reserves figures kept for internal purposes by the companies showed sudden disagreement beginning in 1968, according to the FTC.

The time has long since come when the Federal Government should insist on verified and independent reserves statistics. To the extent that the estimates are imprecise, a range of probable figures can be used. The industry's persistent claims that reserves totals by individual reservoir or field are too confidential to be made public without damaging competition cannot stand, in light of unimpeded operations in other countries where reserves figures are published by the governments (such as Alberta), and in light of the presence of representatives of all the major producers on the AGA committee which now compiles reserves totals from estimates for individual reservoirs.

Withholding of significant quantities of natural gas or deliberately understating reserves during a critical shortage is inexcusable. Even if the quantities being "sat on" are not sufficient to end curtailments, the exposure of speculation by the industry on gas supplies during a shortage should be permitted to affect public conception of whether this industry ought to be freed from Government controls.

IV. IS THE NATURAL GAS FIELD MARKET A COMPETITIVE MARKET?

PRO (Those favoring deregulation)

Yes. The oil and gas producing business is one of the most competitive businesses in the United States. Literally thousands of separate companies compete for opportunities to find oil and gas. Although a number of big companies have won the lion's share of the market, the concentration in a few corporate hands is much less than it is in most sectors of the American economy. The latter day trust-busters who so vigorously condemn the fact that the twenty largest oil companies control more than 70% of natural gas production have not in their wildest dreams hoped to reach that level of competition in steel, automobiles, computers, photographic supplies, or the bulk of the American economy.

The economic studies of competition in the natural gas producing industry are legion, and show conclusively that by any traditional standard of measurement, gas production is a workably competitive market. According to a study by Dr. Norman A. Ture, the number of gas producers (more than 45,000 when individuals and partnerships are included), the independence of their actions, the frequent changes in rank of the major companies, and the low barriers to entry of additional competitors provide a likelihood of competitiveness that is proven by the evidence from the unregulated intrastate market.^{17/}

^{17/} Ture, Norman B. Competition in Natural Gas Production, presented on behalf of the Natural Gas Supply Committee in testimony before the Senate Commerce Committee, reprinted in Hearings on the Consumer Energy Act, October 24, 1973. Vol. I, pp. 329-369.

It is clear that what little market power gas producers may have to force prices up through use of monopoly market power will be more than outweighed by the power of pipelines to force prices down. In virtually any given producing region, there are many times the number of producers than there are pipelines; in some areas, only one pipeline is available. Pipelines can bid producers off against each other to a much greater extent than vice versa; producers are under much greater pressure to sell at the price the pipeline names than pipelines are to buy at the price the producers name. This kind of market power from the demand side is known as monopsony power; it is far greater in the natural gas market than the monopoly power of the sellers of gas.

Those who support FPC regulation often cite the many joint ventures among producing companies as evidence that the various companies are less than wholly independent. Studies by Erikson and Spann^{18/} have shown conclusively that the great number of joint ventures, their frequent changes in membership, the differences in corporate size of the participants, and the fact that production from a joint venture is marketed separately by each participant, suggest more competition, not less. Joint ventures are not formed for the purpose of collusion in order to set prices; they are formed to allow several companies to undertake a project too risky for any individual company. They permit entry by smaller companies in areas where the costs would otherwise be prohibitive, strengthening the competition where it potentially could be quite limited.

18/ Edward W. Erikson and Robert M. Spann, Statement before the Senate Commerce Committee, Hearings on the Consumer Energy Act, November 8, 1973, pp. 745-769.

The only major factor presently limiting competition in this market is Federal regulation itself, which has depressed prices below the market levels they would otherwise reach, driving thousands of small companies into other lines of endeavor over the past few decades, while the major companies have been able to survive by virtue of their strength in overseas and domestic oil operations.

Since the natural gas field market is workably competitive, there can be no justification for continued Federal regulation. There are no similarities between the natural gas industry and the industries traditionally considered public utilities in terms of operations, risk, investment required, or necessary return.

Even the opponents of deregulation concede that if the industry is competitive, there is no reason for regulation: "If the field market is workably competitive, then clearly Federal regulation of field prices is not required and reliance upon 'market forces' to establish rates would be appropriate, from a public policy point of view." ^{19/} By all the traditional tests of market competition, the natural gas producing industry is workably competitive. It is time to follow that fact to its logical conclusion and deregulate. The application by the Federal Government of traditional regulatory techniques and formulas to natural gas producers has been a misfit of policy and reality with tragic connotations both for the gas producing industry and for the nation's energy supply.

19/ Donkin, George L. "The Competitive Effects of Interdependent Actions Among Buyers and Sellers in the Natural Gas Producing Industry," Cornell Energy Industry Study. Reprinted in Hearings on Consumer Energy Act, Senate Commerce Committee, v. 5, p. 2056.

CON (those opposing deregulation)

No. The field market for natural gas -- sales from producers to pipelines -- is both functionally and structurally uncompetitive. For this reason, deregulation would allow skyrocketing gas prices without the protections the market could bring to bear if competition were prevalent.

There are admittedly a large number of natural gas companies, but the industry is dominated by a few -- the major oil and gas companies. In practice, these companies are so tightly joined through a network of domestic and international joint ventures, director interlocks, joint operations in oil refining, pipelining, and distribution, and bank ownership, that they behave virtually as a single company would. When advocates of deregulation point to supposed competition among the companies for offshore leases through multi-million dollar bonus bids, it must be remembered that the Interior Department ascertains a certain minimum necessary bid level below which the land will not be leased. The majors, often bidding jointly, are attempting as much to match the level fixed by Interior as to outbid competitors.

Dr. Schwartz of the FPC has pointed out that, while the domination by the majors of total gas production may not seem overwhelming or uncompetitive (the eight largest companies having perhaps 42% of the market), that is not the relevant market. All gas is not resold each year; it is only the uncommitted gas which is up for sale. Here alone does the true market competition operate. And here the few major companies control the market with as much as 100% of the uncommitted reserves in major producing

areas. The unavailability of verifiable reserves data prevents a complete cataloging of this market influence.^{20/}

In the intrastate market, where recent higher prices for natural gas have put great pressure on the FPC to grant higher interstate prices, studies have shown that many of the major natural gas purchasers are affiliates of the natural gas producing companies.^{21/} It can hardly be argued that arms-length bargaining occurs between affiliates. Yet the intrastate market is constantly held forward as an example of the kind of competition that could result from deregulation.

The conclusion that must be reached is that the natural gas producing industry is not structurally competitive. But one should look beyond the facts about structure of the industry, which merely can be used to suggest probable market behavior, to the evidence that exists about market behavior itself. Is this market functionally competitive?

If the natural gas field market is to be competitive enough to protect the consumer's interest, there must be effective arms-length bargaining between the parties to contracts for the sale of natural gas. Looking at the interests of the two parties to any gas contract, the producer and the pipeline, it becomes immediately clear why deregulation of this market would be intolerable.

The producer's entire interest in the sale is to obtain the highest possible initial wellhead price for the natural gas it dedicates to the

^{20/} Schwartz, Dr. David S., Assistant Chief, Office of Economics, FPC, Statement to the Senate Commerce Committee, Consumer Energy Act, v. 1, p. 215.

^{21/} Op. Cit., Donkin, Ftnt. 19, supra.

pipeline. It will generally commit this gas to sale for twenty years, or until exhaustion of the reservoir, with likelihood of only minor annual adjustments in the price during the course of that period. Thus the producer determines its ultimate return with the initially agreed-upon price, and knows that each one-cent raise in the beginning rate will result in an additional millions of dollars over the life of the deal.

If the pipeline involved in the contract is as eager and as able to bargain for a lower price as the producer is to obtain a higher price, then perhaps an effective arms-length bargain can be struck, protecting the consumer from prices higher than the minimum necessary to purchase the gas.

The pipelines, however, have virtually no interest in lower natural gas prices, for a number of reasons, and are thus willing to pay the producer the rate demanded. Some of the reasons that pipelines cannot or will not bargain effectively are:

1. The pipelines do not actually buy the gas -- the consumers buy it. The pipelines contract for it, but the entire cost of the gas they purchase, at whatever price, is passed through to the consumer under "purchased gas adjustment clauses" which operate without regulatory oversight. Higher gas prices are "no skin off the backs" of the pipelines.

2. The pipelines are acutely aware that natural gas is a declining resource. Since they make money as a return on their facilities, not as a "mark-up" on gas prices, the longer they can continue to use those facilities during an increasing gas shortage, the better off they will be. Thus, the pipeline's dominant interest is to obtain the commitment of the gas to its system. Whatever the price, no pipeline will quibble if the dedication of the gas to it is jeopardized.

3. The pipelines have large volumes of relatively low-priced flowing gas with which to 'roll-in' the prices they pay for new gas. Consumers' prices will only increase a small amount initially from the extremely high prices pipelines will pay for incremental supplies, but the increase will be continuous and inexorable. Of course, to the extent that this old, flowing gas is also deregulated, consumers prices will jump immediately. Nonetheless, the ability to average in the cost of new gas with all the old gas removes a significant incentive for pipelines to bargain for lower prices.

4. The pipelines have begun to plan enormous investments in coal gasification and liquified natural gas to supplement their declining natural gas supplies. These projects are now projected to cost from \$2.50 to \$4.00 per Mcf, compared to the present natural gas average of 32 cents. Since pipelines realize that major additions to their pipeline networks will not be justified during the shortage, their corporate growth of investment (and thus their profits as a return on that investment) would be stymied without such substitute projects as the planned capital-intensive LNG and SNG facilities. Yet these facilities themselves are not feasible at current gas prices. The much higher natural gas prices that would follow deregulation would make the pipelines' coveted investments in SNG and LNG more acceptable to regulatory agencies and the public. Their unwillingness to undercut their potential activities in this sphere is another reason that pipelines would not vigorously seek the lowest possible natural gas prices.

5. All the major interstate pipelines have subsidiaries engaged in gas production. In purchasing gas from itself, a pipeline will pay the highest rate it can, because the rate is passed through to consumers. The general

increase in gas market prices that will result from pipelines paying higher prices to any supplier will benefit the pipeline's own subsidiary. Pipelines can hardly be expected to bargain vigorously for lower gas prices when they themselves obtain the same great profits through their subsidiaries, and when consumers, not the pipelines, bear the costs.

6. Finally, the pipelines are fully aware that consumers will accept higher natural gas prices until they equal the price of alternate fuels at the minimum. No consumer will convert to another fuel unless gas becomes at least as expensive. With alternate fuels averaging in excess of \$2.00 per million Btus while gas is 32 cents, there is a great deal of room for upward adjustment before any gas customers are lost to competing fuels. No pipeline will try to bargain for lower prices when the higher prices will not drive customers away, and bargaining will alienate the producers, opening the gas supply opportunity to an equally desperate and less scrupulous pipeline competitor.

For these reasons and others, pipelines will have no incentive to counter the strong producer incentive for higher prices. The producers in a deregulated field market will name their own prices, and the pipelines will pay them with consumer money involuntarily contributed for the purpose. This is an incontrovertible fact of the current situation in this industry.

That advocates of deregulation can maintain with straight faces that the interstate pipelines, desperate for gas to end curtailments and already offering the producers millions of dollars of advance payments for new gas, have greater "market power" than the major oil and

gas companies who hold the drawstrings on the nation's natural gas supply, and have been demonstrably willing to tighten them, shows the utter bankruptcy of their case for deregulation, and their method of market analysis. In the past, when natural gas was a new industry, pipelines may have been able to pick from among some producers glad to unload what they considered a by-product of their oil production. Now, however, the pipelines are wholly under the thumbs of any producers with gas to sell, and arguing over price is the furthest thing from their minds.

Deregulation would remove the remaining regulatory checks on this structurally and functionally uncompetitive market, to the great detriment of the nation's consumers.

IV. WILL DEREGULATION OF NATURAL GAS BE EXPENSIVE TO CONSUMERS?

PRO (Those favoring deregulation)

No. Deregulation will obviously provide higher prices for producers -- removing the artificial checks on prices and thus providing incentive for new drilling is the whole idea. But consumers will pay only slightly more for natural gas, increasing gradually over the years, and what they pay will be much less than they would have to pay for the alternatives to gas to which they would otherwise have to convert.

This result has been shown conclusively by studies from several independent sources: the FPC staff, the Federal Energy Administration, the Foster Associates, and the academic community. ^{22/}

There are a number of factors that prevent the true cost of deregulation from reaching the soaring heights warned of by such opponents of deregulation as Dr. Schwartz. One is the failure to account for the costs of alternative fuels that consumers must obtain who are cut off from natural gas as a result of the FPC-caused shortage. The greater supply of natural gas which deregulation would elicit, would not have the enormous incremental cost that is claimed because it would prevent the curtailment of a number of users. The FPC staff, in their recent and thorough computer

^{22/} The Federal Power Commission staff has summarized in its recent analysis of the cost of deregulation (see ftnt 23), the various other studies which have been prepared on this topic. The FPC summaries and tabulation have been included in this report as Appendix B.

study of the cost to consumers of deregulation showed that this factor would remove the bulk of the burden of higher gas costs, and that early in the next decade, deregulation would show a net benefit to consumers instead of a net cost. ^{23/}

Another factor overlooked too often is the higher cost that will come to consumers if current regulation is continued and curtailments continue to grow from having to divide the costs of the pipeline transportation among fewer customers. It must be remembered that the purchased cost of gas is only a fraction of the average consumer's bill: the transportation and distribution charges are the largest part of it. If large industrial customers are cut off, they will not be making any contributions to the costs of the pipeline and distributor, and the customers still receiving gas will experience great price rises as a result. One system calculated that a 20% curtailment would lead to a 24% rate increase for each remaining customer and that a 50% curtailment would lead to 100% rate increase. ^{24/}

The use by pro-regulation analysts of an OPEC-oil equivalent price for natural gas after deregulation, about \$2.00 per Mcf, does not fit with reality in the unregulated market. After 18 months of OPEC-determined oil prices, only occasional deals are reported which reach OPEC price levels and the bulk of the gas sales are still being made at between \$1.00 and \$1.25.

23/ Federal Power Commission, Intra-Agency Task Force, A Preliminary Evaluation of the Cost of Natural Gas Deregulation. Washington, D. C. January, 1975. at p. 5.

24/ Algonquin Gas Transmission Company, cited in Statement of Joseph Hammond for the Natural Gas Supply Committee before the Senate Commerce Committee, Hearings on the Natural Gas Production and Conservation Act of 1974, December 4, 1974, at p. 181.

The Project Independence study anticipates that long term market clearing prices will be in this range, also. While substantially higher than current average new gas prices in interstate commerce, the market price would not be so high that gas users would be forced to other fuels. And the impact on consumers would be very gradual because of the time required before old contracts at lower prices expire.

As Foster Associates calculated in an update of their earlier study of natural gas deregulation costs to consumers, even at \$1.75 per Mcf. at the wellhead -- a much higher price than most experts think will prevail and the price assumed by opponents of deregulation -- the average residential consumer's gas bill will only increase over the next several years an average of between \$10 and \$20 per year, less than 10% per year. ^{25/} If deregulation succeeds in stimulating new supplies of natural gas enough to ease curtailments and assure gas service for years ahead, consumers will be getting a bargain.

Opponents of deregulation exhibit a preference for calculating the total national cost of deregulation, rather than breaking it down in terms that show the impact on the average homeowner -- the numbers seem more impressive. But even if the most outlandish total estimate of the cost of deregulation, that of Lawrence Kumins of the Congressional Research

25/ Foster Associates, Inc. The Impact of Deregulation of Natural Gas Prices, Washington, D.C. March, 1975. See table 12, Projected Year-to-Year Increase in Annual Cost to the Residential Consumer, Partial Deregulation.

Service, ^{26/} were accurate, the total cost (\$75.6 billion between 1974 and 1980) is less than the cost of three years of oil imports, the probable substitute for the natural gas which will not be there without deregulation. And the money stays at home.

Of course, this figure is many times higher than that given in other studies. The FPC Staff estimates a cost of about \$2 billion per year, or \$10 billion cumulatively from 1974-1980. ^{27/} Foster Associates estimates cumulative costs of \$2.5 to \$4.5 billion for existing sales, plus about \$.5 billion as of the end of the period for each addition of 100 billion cubic feet of gas. ^{28/} The FEA estimate is not given, but can be inferred to be close to the levels found by the FPC and the Foster Associates. ^{29/}

Estimating the dollar impact of deregulation is a highly speculative activity, but it is clear that the impact will not be as large as some have feared, and that the benefits to the nation of increased domestic clean energy will far outweigh the costs.

^{26/} Kumins, Lawrence, Economic Impact on Deregulation of Natural Gas, Economic Division, Congressional Research Service, Library of Congress. November, 1974. Prepared for the Honorable John E. Moss, House Committee on Commerce and Finance. Summarized in Appendix B.

^{27/} Op. Cit., Ftnt 23, p. 5.

^{28/} Op. Cit., Ftnt 25, p. 405.

^{29/} Federal Energy Administration, Office of Economic Analysis, An Analysis of the Economic Impact of Natural Gas Deregulation. Technical Report 75-12, March 18, 1975. 30 pp. The calculations made by FEA of the impact on the average residential consumer's bill are below those of the Foster Associates, and the assumption of price per Mcf are below those of both the FPC and Foster Associates.

CON (Those opposing deregulation)

Yes. Deregulation will be enormously costly to consumers, and few if any benefits will result.

The only possible benefit from deregulation would be a substantial increase in the supply of natural gas available. As was pointed out in answer to Question II above, little if any additional gas will result. The studies of the cost impact of deregulation which minimize the cost by balancing new quantities of gas against the imported fuels that would otherwise be needed are not based in reality. Their anticipations of new supply are all grossly overstated.

The FPC staff uses two alternate supply hypotheses with its projections: level production, and slightly increased production. Neither case is defensible in light of the FPC staff's own summary of the gas shortage. (Appendix A). After such egregious assumptions, it is little wonder that the FPC can conclude that deregulation is cheap. Foster Associates and the FEA study similarly presume hypothetical additions to supply resulting from deregulation that cannot be defended on the basis of reported statistics, geological indications, or past or probable performance of the producing industry. It is not difficult to imagine, after deregulation is achieved, the excuses that will be used to justify not having actually found these incremental amounts of natural gas now depended upon to justify such price rises as will result. Suffice it to say that the evidence that gas supply will increase at all as a result is, at best, highly conjectural, and, for the most part, absent.

A crucial factor is the price for natural gas that will result in the field market after deregulation. Because of the shortage, the central determinant of the deregulated market price will be the point at which a gas consumer would be willing to convert to the use of an alternate fuel. Demand and supply cannot coincide when supply is frozen unless demand falls, so rising gas prices will serve^{to}/inhibit demand for natural gas.

No gas customer will cease using natural gas until its price equals or exceeds the cost of alternate fuels. He may grumble, but he will continue buying gas because it will be the cheapest alternative. Those many industrial and other users who must use natural gas for essential feedstocks or processes will not convert to another fuel regardless of the cost of gas. Those who could conceivably switch will not switch until gas prices not only match alternate fuel prices, but exceed them by enough to justify the cost of converting to other equipment. One consulting firm estimated that the cost per Mcf saved for an electric utility to switch from gas to oil would be about 7 cents. The cost to a homeowner would be about \$1.50 per Mcf saved. Thus until gas prices rose to \$3.50 per million Btus, it would not make economic sense for a homeowner to convert to oil at \$2.00 per million Btus, the OPEC price level and current marginal cost of energy in the economy. In addition to the basic cost of alternative fuels and the distributed costs of converting to the use of alternative fuels, there are the inherent advantages of clean, easily handled, controllable, pollution-free natural gas which will also be somehow expressed in the price buyers are willing to pay at points of consumption.

If this will determine the price consumers will be willing to pay at points of consumption, one can determine the amounts pipelines are willing to pay producers by subtracting the costs of transmission and distribution. Such costs average 34 cents for industry and \$1.13 for residential customers, according to FEA. But averages are deceptive; consumers close to producing fields pay a fraction of the transportation costs that consumers in distant areas pay. They will continue to obtain the bulk of natural gas after deregulation because they can pay producers more and still have lower total costs. The market clearing price in the producing fields will therefore not be reduced by the effects of transportation costs as much as might be expected. Considering all the factors involved -- the price of alternate fuels, costs of conversion to alternate fuels, inherent advantages of natural gas, diminished only slightly by transportation costs -- the market clearing price of natural gas after deregulation in the producing fields will probably range from \$2 to as much as \$4 per thousand cubic feet. The uncompetitiveness of the market and rolled-in prices might well yield prices that will be above the theoretical market-clearing levels.

The fact that pipeline companies and others are proceeding with plans for synthetic and liquified gas facilities with projected price requirements of \$3.50 to \$4 per Mcf is solid evidence that wellhead prices at that level are not beyond the private expectations of the natural gas industry, although far higher than its public pronouncements.

Prices for natural gas have risen and will probably continue to rise significantly under current or modified regulation, but should be kept below the deregulated levels noted here. The total savings to consumers of maintaining regulation will be truly significant.

Deregulation would, moreover, be wholly inflationary -- no greater contribution to GNP would result from much higher expenditures for natural gas and products made using natural gas. In addition, there is a great likelihood that higher gas prices paid by consumers in the form of more expensive products produced using gas will not be passed on without customary mark-ups to keep profits as a percentage of revenues at the same percentage levels, further exacerbating inflation.

In conclusion, the cost of deregulation to the consumer will be very large. Lawrence Kumins' estimate of \$75.6 billion through 1980 is not unrealistic.^{29/} To suggest that the cost of imported fuels will be saved by paying the higher cost of deregulated gas is absurd: we will still need the same quantity of imported fuel because we will still have the same quantity of gas available. There is no justification for raising our national gas bill by this huge amount. Those consumers who have been misled into thinking that deregulation will end curtailments, the uncompetitive and already profitable natural gas industry, and academics mesmerized by the illusory possibility of a functioning market mechanism to end the energy crisis, should not be permitted to stampede such a costly and ineffective measure through Congress. Deregulation of natural gas is a bargain for the United States indeed: a terrible bargain.

^{29/} Op. Cit. Ftnt. 26.

VI. WILL NATURAL GAS PRODUCERS HAVE ADEQUATE INCENTIVE WITHOUT DEREGULATION?

PRO (Those favoring deregulation)

No. Without deregulation, producers will be unable to find sufficient investment to explore those prospective gas fields that are identified, unable to make a reasonable return on the gas they do find, unable to produce gas in the smaller and more distant fields, and unwilling to continue in such an unrewarding and difficult business when the money it requires can be more safely and profitably invested elsewhere.

The regulated rates set by the FPC are stated to contain a 15 % rate of return to the producer. This return has seldom been received by individual companies, and has never been achieved by the industry as a whole, because of deficiencies in the FPC cost-based methodology of setting rates which sets the phantom 15% return. The full cost of producing natural gas is not included in the formula to which the 15% return is applied, the averaging of the costs from wide areas rules out drilling for higher than average cost prospects, and the use of historical test-year cost data does not account for the inflation prevalent throughout our economy and particularly severe in the oil and gas drilling industry.

Especially since Congress has seen fit to eliminate the oil and gas depletion allowance, which enticed large amounts of money from outside investors into the exploration and development process, the capital that is needed for new natural gas production must be generated internally by oil and gas producers. But the actual return to gas producers on their investment, according to the National Petroleum Council, has been in the range of 6% to 8% on average net fixed assets. And this average takes

into consideration old easier successes as well as new investments, which have achieved a much lower return if any. No one will invest in a business as risky as natural gas exploration for a return no higher than can be obtained from a long-term loan.

It must be remembered that the alleged 15% return is only obtained by those who are successful, yet must encourage them to continue an activity where the great majority of the most wells are dry. The FPC has refused in its rate-setting decisions to recognize and account fully for the increasing difficulty of locating new gas fields, preferring to use historical averages of finding rates. Thus even if a 15% return were actually achieved, it could not reward the producers enough to prompt continuing expenditures for new gas production, because it is not calculated on a basis which accurately or fairly anticipates the gas discoveries that can be made.

When one looks at the alternate opportunities that are open to producers for investment of capital, there is little wonder that production of natural gas for the interstate market is about the least attractive. The profitability of gas production is less than that of the average major U. S. industry.

A few simple calculations show dramatically the need for additional capital in gas production. The amount of natural gas discovered in 1973 per thousand feet of successful well drilled was about 110,000 Mcf.^{30/} In 1974, according to the American Petroleum Institute, 38 million feet were

^{30/} This productivity figure is a rough average of productivity figures calculated from drilling data of the American Association of Petroleum Geologists and from World Oil magazine, using American Gas Association data of additions to reserves. The actual figures are 113 Mcf/ft. for World Oil, and 104.4 Mcf/ft. for AAPG.

drilled in successful gas wells.^{31/} If one assumes that about half of the unsuccessful drilling, the dry holes, are allocable to gas drilling, and half to oil drilling, it took about 70 million total feet of drilling to add the 4,165 trillion cubic feet of gas that were added to reserves through new discovery in 1974.^{32/}

According to the Joint Association Survey of the U.S. Oil and Gas Producing Industry, the cost in 1973 of drilling each foot of a gas well was \$27.46 and the cost of each foot of dry hole was \$19.21.^{33/}

The small amount of gas reserves added in 1974 using these figures, cost \$1.65 billion for the drilling alone. The FPC staff asserts that "... in order to hold production at the 1973 level, annual reserve additions must rise to the 22-24 Tcf range for 1975 and then remain at that level".^{34/} The amount of capital that must be raised for drilling alone if this goal is to be reached will need to rise to levels of about \$9 billion per year.^{35/} This figure for the amount of capital required annually to maintain current production levels is higher than the extra annual cost that has been calculated

31/American Petroleum Institute, Quarterly Review of Drilling Statistics, Annual Summary, 1974. Vol. VIII, No. 4, April, 1975, p. 14.

32/ American Gas Association, Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada, and United States Productive Capacity as of December 31, 1974. June, 1975.

33/Joint Association Survey of the U.S. Oil and Gas Producing Industry -- 1973, Sponsored by the American Petroleum Institute, Independent Petroleum Association of America, and the Mid-Continent Oil and Gas Association February, 1975. Figures calculated from date on page 8.

34/Op. Cit. FPC, Appendix A, p. 13.

35/ If \$1.65 billion yields 4,165 of new discoveries, new discoveries of 22 to 24 Tcf will require approximately \$10 billion, assuming stable finding rates, stable drilling costs, and access to sufficient equipment and geological prospects.

to result from deregulation by anyone's estimates, including those of the opponents of deregulation, and is more than twice the total revenues currently received from interstate sales by producers. ^{36/}

This rough calculation is not adequate to give a solid indication of the cost of ending the gas shortage, nor to impart any precise estimate of the investment needs of gas producers, but merely to suggest the enormity of the needed investment. It is unalterably clear that the need for capital in the natural gas producing industry is great: Current FPC rates provide the incentive for only one-sixth of the drilling that is necessary at current finding rates to maintain current production.

Recent experience has clearly indicated what can be expected if the incentive is provided by deregulation. Drilling for natural gas is approaching record levels -- but only in the unregulated intrastate market. Off-shore drilling, which is on Federal lands and can only produce for the regulated interstate market, is still at disastrous levels.

In the face of the drilling evidence from both unregulated and regulated producer markets, it boggles the imagination that opponents of deregulation can suggest that FPC rates provide the incentive that is needed. The country cannot afford to wait until these benighted "consumer protectors" face the facts before letting natural gas prices solve the shortage through the marvelous mechanism of a free market.

36/ According to the FPC, producers were paid \$3.11 billion by interstate pipelines for 11.3 Tcf of natural gas during the twelve months ending February, 1975.

CON (Those opposing deregulation)

Yes. Gas producers currently have great incentive to discover and produce natural gas. The FPC has stretched its statutory guidelines almost to the breaking point in order to justify the constant and overlapping rate proceedings it has entertained in the last five years, each of them granting higher prices than the last, and each of them adding to the incentives enjoyed by the producers. Gas prices have risen from less than twenty cents per Mcf for new gas in 1970 to more than fifty cents in 1975 under this version of FPC consumer protection. Deregulation will, as indicated above, quadruple the currently permitted FPC rates, to amounts in excess of \$2.00.

There has been a vicious attack by the industry on the use in regulation of their prices for natural gas of evidence relating to the costs of natural gas production. Yet cost evidence is obviously the key source of information for the determination of prices. Before the general energy crisis and gas shortage allowed partial or complete deregulation to become a political possibility, the industry's campaign for higher prices in Congress revolved around amendments to the Natural Gas Act which would have required the FPC to consider, when setting prices, evidence of the prices of alternate fuels, the premium fuel characteristics and environmental desirability of natural gas, and other so-called market factors. These past proposals would have forbidden the FPC to look into the producer's actual costs.

Why does the industry attack cost-based pricing and why have they proposed in the past to eliminate cost as a reference for regulated prices?

Simply because there is no evidence based on costs actually incurred by the producers that they need higher prices than the FPC now allows, to make a very substantial profit. Especially now, when the FPC has given the producers the benefit of virtually every doubt concerning how their costs should be assessed and accounted for, these companies have realized that the upper limits of justifiable prices without demonstrable cost increases have been reached by the Commission.

The FPC has considered all the factors bearing on the cost of producing natural gas -- the exploration, the dry holes, the taxes, the royalties, acquiring the leases, overhead, other production facilities -- in short, everything that is closely enough related to natural gas production to be thrown into the pot. The producers have not been able to suggest to the FPC factors that should be considered that are not now considered. And the FPC has accepted the producer's own information in determining the levels of cost that should be allowed for each of the factors, with minor exceptions. In arriving at its latest price decision, the FPC accepted the producers' contentions that a discounted cash flow analysis should be used to calculate the rate of return, and raised the allowable price to more than 50 cents per Mcf.

The FPC supports deregulation. By any standards, the FPC is as sympathetic to the industry's case for higher prices as it could be. Yet try as it might, the Commission apparently could not justify a price higher than 50 cents.^{37/}

37/ Federal Power Commission, Docket R. 389-B, Opinion 699-H, Opinion and Order on Rehearing, issued Dec. 4, 1974.

What this means is that there is a two-word definition for every cent above 50 cents that gas producers receive: windfall profit. Revenues above the amounts needed to cover the investment of the producing company and provide that company a real 15% return on its investment. Even during these times, if 50 cents per Mcf provides a 15% return, 75 cents will provide profits of between 50% and 100%. Deregulated prices for natural gas of \$2.00 and more stand a good chance of placing the natural gas producing industry among the most obscenely profitable enterprises in the history of the nation. Is such a rush of money into the pockets of the natural gas industry necessary? Hardly.

To look at it another way, if the natural gas producing industry is as competitive as it claims to be, and if additional efforts on its part can resolve the natural gas shortage, as it claims, those efforts, one would suppose, would be forthcoming at the highest price the industry itself can justify based on its actual experience of cost and need. The FPC has repeatedly done its best to permit the industry to receive that price, buying the industry's contention time after time that more incentive is needed to reverse the shortage, and awarding a price at or near the price the producers requested. But the discouraging trends continue, the shortage worsens. If we now disregard this experience and once again give the industry all the incentive it claims to need, we should not only expect no better, but may deserve no better.

VII. CAN THE NATURAL GAS SHORTAGE BE EQUITABLY MANAGED WITHOUT DEREGULATION?

PRO (Those ^{SUPPORTING} ~~opposing~~ deregulation)

Probably not. In our system, we rely on the market mechanism to distribute goods and services to those whose need for them is greatest. Supply and demand operate to set prices and quantity consumed for each of the commodities we depend upon. An incredibly complex network of producers, servicers, and consumers, our economy has achieved by the unimpeded application of basic economic laws, heights not approached by any other history.

In recent decades, the Federal Government has for one reason or another seen fit to intervene in the market's functions. One such intervention, a particularly damaging one (as some originally warned), has been the imposition of Federal price controls on the functioning of the market for natural gas in the producing fields. By restraining natural gas prices, the Federal Power Commission has proven the validity of the textbook precepts on how to create a shortage. Supply dropped off for lack of sufficient economic inducement while demand soared due to too much economic inducement. Now the crunch has come and the Federal Government is trying to remedy the shortage caused by manipulation of the market through further manipulation of the market. The distortions of market demand caused by artificially low prices are being addressed not through the removal of the artificial price barriers, but through artificial curtailment priorities and allocation plans.

Just as the shortage of supply is being perpetuated by the continuation of Federal price controls, so the distortions and agonies of unfulfilled demand are being perpetuated by the same refusal to let the price of natural

gas rise to its normal levels. Rather than allowing normal market forces to discourage wasteful and lavish uses of natural gas by reducing its price advantage, we have chosen to determine ourselves those uses which must be discontinued first and order them to cut off. Rather than let the highest priority customers indicate their seriousness of their needs and value of their products made with natural gas via their willingness to continue purchasing it when other users have opted for other fuels, we are engaged in unseemly and cumbersome bureaucratic and political proceedings to decide which uses for natural gas are the most important.

In its curtailment efforts, the FPC is wholly unable to be guided in the appropriate degrees by the social utilities of the products of separate manufacturers, by the effect on the overall system of goods and services of cutting off one large user as opposed to another, by the changing needs of our society for a different mix of products over time. The FPC's priorities, which by determining the availability of natural gas determine the course of much of our industrial production, are only based on such superficial distinctions as the amount of natural gas consumed, whether the gas is used under boilers or not, and whether the contract was originally a firm or interruptible contract. The market would allocate natural gas in accordance with the former criteria, not the latter, while it simultaneously assured the greatest possible supply of natural gas.

This is not to say that the distortions which have been ingrained in this market for twenty years can be removed overnight or painlessly. Some guidance and protection by the FPC is probably necessary as market forces assert themselves again to provide those who must convert from natural gas the necessary lead time to do so. But in the long run, artificial

allocation of as essential a commodity as natural gas with all its inherent slowness, insensitivity to true needs and values, and susceptibility to political influences, is doomed to failure. We must set a course that will return the allocation of this vital fuel, along with its prices, to the control of free market forces at the earliest possible date. To perpetuate artificial rationing of natural gas in defiance of the market system that has made this country history's most productive is to threaten the continuance and health of that productivity.

CON (Those opposing deregulation)

Yes. Despite the difficulties which always accompany the allocation of a material during a shortage, that allocation is and will be necessary, and can be performed in a manner which preserves the consumption of natural gas for the most crucial users and for those least able to adapt to the shortage.

Natural gas has been a very popular fuel, and is a bargain compared to other fuels at their exorbitant current prices. Since no one who uses gas will stop using gas until its price at least reaches the levels of alternate fuels, and probably not until the price exceeds that of alternate fuels by enough to account for conversion expenses and the inherent advantages of gas, the shock of immediate reliance on market forces to discourage demand and to bring demand and supply into immediate equilibrium would be too great for our society to stand.

Moreover, it is a fallacy that demand which might not have been developed had prices been higher will be discontinued when prices go higher. Although alternatives to gas and the equipment to use them were available

when the initial decisions of many users to go to gas were made, now that gas burning equipment has been installed, the determination with which users will cling to gas is far greater than was their determination to get it in the first place. Demand for gas once incurred is not as easy to discontinue as it would be to discourage in the first place.

As pointed out in response to other questions, however, the demand for gas that blossomed in recent years would have grown in the same manner and to the same extent without deregulation, and would be just as ingrained and hard to change at present. To allow higher prices to drive this demand out of the market in accordance with ability to pay for natural gas may not accord with the true economic and societal needs of the United States, and clearly will not accord with equity. For a poor family heating with gas, for example, the expenses of installing equipment to burn other fuels and the price of other fuels are such that they would be the last to convert. But the cost of obtaining the same amount of natural gas after deregulation could easily destroy the delicate financial balance such a user maintains. Hospitals, schools, small businesses, and commercial establishments are in a similar situation in many cases. The Federal Government should protect these users from the effect of the higher prices if it can. And, indeed, it presently is protecting these users by placing them in the highest priority categories for service when others are cut off. But after deregulation, such protection will not be possible.

The market mechanism, Adam Smith's "invisible hand" is a wonderful tool for allocation and pricing of goods and services. But it is not error free. For example, the free market cannot plan for the future: after a certain number of years, the discounted value of anything is almost nothing.

Although free market economics dictated earlier this century that oil companies should flare their natural gas into the atmosphere, wasting half of the gas we have ever discovered, that use of natural gas could hardly be considered beneficial in the long run. The same market forces, largely unaffected by the FPC, gave rise to the great demands for natural gas that now exist and must be reckoned with. It is the function of Government to prevent such unchecked market power from forcing massive short-term changes with profound social effects. The FPC is performing this function with its curtailment program.

The FPC is doing this job reluctantly, without the information resources it should draw upon, and in an ad hoc fashion. Decisions are taking too long, and it is not clear that proper importance is being placed on the need to maintain employment, to equalize the shortage among different geographical regions, and to coordinate gas curtailment with access to other fuels. But these problems are recognized and will be worked out. The enormous impact of allowing the price function to do this job is being avoided.

Without massive and unforeseen additions to reserves, the shortage we have begun will continue indefinitely. The FPC must design its curtailment program with this in mind, rather than as a temporary expedience. But such a program can be structured, and can function equitably, and need not subject our economy to the brutal shock of higher prices in the short run or major distortions over the coming years.

ADDITIONAL ISSUES AND CONCLUSION

A number of issues about which there has been debate or perhaps should be debated have not been dealt with in the foregoing arguments.

For example, opponents of deregulation asserted strongly for several years that the gas shortage itself was not real, but was a mirage deliberately created by the major oil companies through such devices as withholding of new reserves and understatement of reserve information. It is now generally accepted that the gas shortage is real -- that the amount of gas that may have been withheld and not reported, while possibly significant, is not enough to make up the curtailments of service that are occurring.

Another issue not fully treated is the merits of the actions the FPC has taken since 1970 to address the problem. Proponents of deregulation have generally maintained that the FPC actions have consistently been too little, too late. Opponents have asserted that the FPC's actions have exacerbated the shortage by raising price expectations of producers, rewarding those who have sat on quantities of natural gas. These actions are now largely fait accompli, however, mooting the debate over their desirability, and all parties concede that they have had virtually no discernible effect on the course of the shortage. The current debate is centered over whether or not to remove the FPC from the picture entirely, and not over what the FPC should be doing. If it is decided not to deregulate natural gas producers, then the debate over how to regulate them fairly and effectively will be renewed.

One issue which perhaps should be considered and has generally not been discussed is that of the maximization over the long term of our remaining natural gas resources. All parties, for or against deregulation,

now favor the maximum possible production of gas from our natural gas resource base. But the total exhaustion of the resource is in sight and maximizing current production will only speed the day when there is no natural gas for the most essential purposes, much less the wasteful ones. It has been suggested, but not vigorously argued as yet, that our best long term interest is not in maximizing current production and maintaining current uses to the bitter end, but in conserving our remaining quantities of this precious commodity for its uses as a raw material in petrochemicals and such products as fertilizer. Rather than trying feverishly to reverse the decline in gas production, it might be argued that we should accept it to preserve our long term best interest.

Finally, it should be pointed out that new technologies and sources of gas have been investigated that could allegedly provide natural gas that we now assume we will never have. For example, some scientists and companies have indicated that beds of hydrocarbon-bearing shale which underly much of the Eastern United States may contain large amounts of producible natural gas which have been simply overlooked in the current consideration of the shortage. Massive investment in coal gasification, liquified natural gas facilities, or production of gas from petroleum liquids could also contribute more to our supplies than has been generally anticipated. Untested technologies such as large-scale manufacture of methane (the basic constituent of natural gas) through the use of lasers have also been proposed, and could potentially reverse the dire situation that now appears. The effects of these potential developments, because they are unknown, have not figured prominently in the current debate over natural gas policy.

In conclusion, the debate over deregulation of natural gas has been waged in and out of Congress for more than twenty-five years. This session of Congress, prodded by the developing shortage of natural gas, may finally decide the issue. The ramifications of that decision will be felt beyond the immediate arena of natural gas production and consumption. Our general energy policy will be profoundly affected by the approach taken to natural gas issues. Indeed, the approach this country takes to resources in general, many of which may run short in the near future as natural gas has already, will be guided by the precedent we set in our natural gas policy. To deregulate or not to deregulate is an enormously divisive issue. This paper has depicted that issue in a highly polarized fashion. There are many suggested compromises in the legislation that has been introduced, most of which would deregulate partially, or phase deregulation in over a long period. These compromises may thus draw from the strengths of both arguments to some extent. Although this paper presents the issues in an either-or format, because that is the nature of this sort of an analysis, the actual decision is not necessarily one or the other of the positions presented, with no middle ground. In all probability, Congress will fashion an approach between them.

APPENDIX A



FEDERAL POWER COMMISSION

**A REALISTIC VIEW
OF
U.S. NATURAL GAS SUPPLY**

STAFF REPORT

**BUREAU OF NATURAL GAS
WASHINGTON, D. C.
DECEMBER 1974**

PREFACE

This is the latest in a series of reports dealing with the prospects for future national gas supply prepared in the Bureau of Natural Gas. Our 1969 report warned of the impending supply difficulties which had their origin in the late 1960's. A second report issued in February of 1972, dealt more comprehensively with the subject of gas supply in that it addressed the 20 year period extending from 1971 through 1990 and additionally included consideration of the requirements for gas and the prospective availability of gas from supplemental sources. A third exhaustive, in-depth study of conventional supply, demand and projected supplemental supply was conducted as part of the National Gas Survey. While this third report has not yet been published in final form, preliminary drafts have been made available to the public prior to final Commission approval.

The data generally available to forecasters in the National Gas Survey study extended through 1971. We now have two additional years of reserve addition data available and while gas well drilling increased significantly in each of these years, additions to lower 48 state reserves continued at low levels. The downward trend in annual reserve additions which began in 1968 has thus become a trend of six years duration and the impact of this downtrend is being increasingly reflected in the inability of the industry to produce gas at rates sufficient to meet firm requirements. The continuation of these low levels of additions to reserves would appear to indicate that the experience of recent years is not an aberration but an occurrence of historical significance.

Because conventional production from the lower 48 states will be the keystone of the Nation's gas supply for many years to come, this study was undertaken to develop an updated perspective of the implications which these recent trends may have for the future. This report does not generate specific forecasts for the future but rather considers the future production which would become available from a continuation of recent historical trends of additions to reserves.

The National Gas Survey study generated a number of possible levels of production for future years. These ranged from 14.8 Tcf in 1985 under conditions of little or no change from current trends (Case I) to 23.5 Tcf for that same year under the most

optimistic assumptions (Case IV). The general assumptions relating to lower 48 state conventional production in Case I were that the then current wellhead prices would be inflated at 4 percent annually through 1975 and then remain level (25-27¢/Mcf) through 1990. No development of the Atlantic offshore area was anticipated and only a low level of development was projected for the Gulf of Mexico and Pacific Offshore regions. In the most optimistic case, it was assumed that wellhead prices would range from 50 cents per Mcf in 1975 to \$1.21 per Mcf in 1990, after adjustment for inflation, and that development in all offshore areas would take place according to forecasts provided by the United States Geological Survey. Intermediate cases (Case II and Case III) were developed based on assumptions of price and offshore development lying between these two extremes. The study presented here indicates that if present reserve addition trends continue, future production will fall within the lower range of the four cases developed in the earlier National Gas Survey work.

The data utilized in the preparation of this report is, in general, available in the public files of the Federal Power Commission and in reports of industry trade associations and committees. The interpretations and conclusions drawn from the analysis of these data represent the views and opinions of the Bureau of Natural Gas staff members who prepared this report and do not necessarily reflect the views of the Federal Power Commission or of individual Commissioners.

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* * * * *

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INTRODUCTION

Chaotic energy developments of the past year, particularly the oil embargo and its attendant problems, have diverted attention from another significant part of the "energy crisis" -- rapidly deteriorating supplies of natural gas. This report is an attempt to refocus attention on the realities of the U.S. domestic natural gas shortage and the somber prospects for the future.

The gas supply problem has not yet had an impact on our daily lives in the manner of the gasoline and fuel oil shortages, nor have soaring prices been experienced as with coal, oil products and electricity. Yet, it is just as real and just as ominous as the energy events that dominated the headlines during the past year. Not only is the gas shortage worsening, with little hope of reversal in the near future, but the Nation's capacity to manage a prolonged gas shortage has been seriously impaired by tight supplies and high prices of alternate fuels and by a new dimension of the natural gas shortage -- declining annual production. In prior years, even with firm service curtailments, production continued to increase. Now, an unavoidable and rather rapid decrease in annual gas production will intensify an already serious situation in the decade ahead.

In a staff report five years ago the Bureau of Natural Gas warned:

"Evidence is mounting that the supply of natural gas is diminishing to critical levels in relation to demand. . . . On the basis of current trends, only a few years remain before demand will outrun supply."

That report, "A Staff Report on National Gas Supply and Demand (Sept. 1969)", served a clear warning of an impending natural gas shortage. The events of the past five years have fully validated that warning. However, insofar as the report erred, it erred on the side of understatement. The gas shortage arrived sooner and impacted more severely than anticipated and today shows no sign of abating.

In a follow-up report released in February 1972, the Bureau of Natural Gas predicted that gas production would peak in the mid-seventies, and that shortages would be of long duration leading to supply deficiencies of 9 Tcf in 1980 and 17 Tcf in 1990, even after optimistic allowance for new supplies from supplemental sources such as the gasification of coal and gas imports.

In our 1969 report we stated that:

"A major new government-industry program is needed immediately to insure the continued growth of natural gas service during the next decade. The program must be directed to speeding up the exploitation of the natural gas resource base and the development of supplemental gas sources."

Today, five valuable years have elapsed and no "major new government-industry program" has been launched which would insure gas service continuing at present levels, much less at levels necessary for continued growth. The natural gas proved reserve inventory continues to decline, curtailments of firm requirements continue to increase, and, as this report will show, the gas industry, and particularly the interstate pipeline companies, are obtaining only a fraction of the new reserve additions necessary to maintain present service.

For the short term, increasing supply shortages will cause increases in firm service curtailments, widespread plant and business shutdowns and local unemployment and economic problems. In some regions, residential consumers could be affected. For the longer term there are a number of policies which can provide new increments of supply. Increased exploration incentives and accelerated leasing of Federal domain lands are the primary policies which should be pursued in the development of our lower 48 state conventional gas resources. Other policies available include the development of supplemental sources such as gas from coal, synthetic gas from liquid hydrocarbon feedstocks, LNG imports and the

development of our Alaskan gas resources. However, even if the above options are immediately adopted as National Energy policy, a decline in available supply probably cannot be forestalled over the time period considered in this report. Federal, State and local policies for coping with this pervasive natural gas shortage must therefore include reallocation of available supply to high priority uses together with nationwide conservation and conversion to alternate fuels wherever feasible.

THE UNDISCOVERED NATURAL GAS RESOURCE BASE

The rate at which natural gas reserve additions can become available in the future is critically dependent on the size of the economically recoverable undiscovered natural gas resource base. The prevailing opinion in the past has been that there is a vast amount of undiscovered natural gas remaining to be developed in the earth below the lower 48 states and the adjacent offshore waters. It has also been taken for granted that this large untapped resource could be rather readily developed by increasing the magnitude of the industry's exploration effort through incentives of one sort or another. This belief in a vast undiscovered natural gas resource base has been premised largely on estimates published over the years by both the United States Geological Survey (USGS) and by the Potential Gas Committee (PGC), an industry sponsored group. The current USGS estimates of the lower 48 states undiscovered natural gas resource base range between 725 and 1,450 trillion cubic feet (Tcf). The PGC undiscovered estimate is 568 Tcf.

These large estimates have been recently questioned by a distinguished group of scientists who are offering estimates ranging between one-third and one-half of the USGS low estimate of 725 Tcf. In this category the most recent estimate of the lower 48 state undiscovered natural gas resource base is 234 Tcf by John D. Moody, former Mobil Oil Company senior vice president for exploration and production. He is generally supported in his estimate by Richard Jodry, senior scientist with Sun Oil Company, by M. King Hubbert of the USGS and by a Canadian geologist, F. K. North of Carleton University, who concluded in a study prepared for the FPC's National Gas Survey that the undiscovered natural gas resource base ranges between 400 and 600 Tcf.

In 1962, Hubbert made a remarkably accurate, but controversial, forecast that U.S. oil production would peak and start to decline in either the late 1960's or early 1970's. U.S. oil production actually peaked in 1970 and Hubbert's forecasts are now accorded increasing respect in scientific circles. In 1962, Hubbert forecast that U.S. natural gas production would peak in 1976. In 1973, the growth of total U.S. natural gas production was negligible and preliminary data indicate that 1974 will likely mark the first year of decline.

The differences among the various estimates are so drastic and so crucial in terms of U.S. energy policy making that a committee of the National Academy of Sciences is now attempting to mediate the dispute. The public policy implications of the dispute are momentous. If the new low estimates of the resource base are more nearly correct, then programs designed to stimulate exploration are not likely to bring about a significant sustained increase in reserve additions or forestall a decline in production for future years. Such programs could, however, retard the rate of production decline which in itself would be of great importance.

Events of the past few years have tended to lend credibility to the lower range of estimates. There has been a significant increase in the level of exploratory drilling for gas over the past several years, yet discoveries and reserve additions continue to decline. Presumably, the oil companies are drilling their best prospects but are finding fewer gas deposits of significant size.

When considering the undiscovered natural gas resource, whatever its magnitude may be, one must be careful of the concept involved. Some energy commentators have used the word "supply", or "number of years supply" in connection with undiscovered resource estimates. This is erroneous and misleading. It is meaningless to equate undiscovered resources to future levels of production necessary to meet requirements, without consideration of the constraints on industry capabilities and performance and the nature and occurrence of the resource base including characteristics of gas deliverability. The future transfer of presently undiscovered resources to the supply inventory takes place only through the mechanism of discovery and subsequent development.

It is well known that for any finite, depletable natural mineral resource the large, high-grade, easy-to-find deposits are discovered during the early years of the depletion cycle and that the later years of the cycle are marked by the discovery of smaller, scattered deposits and the development of technology to exploit large, lower grade deposits. While large, low-grade deposits of natural gas are known to exist,

particularly in formations with low permeability, acceptable production techniques do not appear to be presently available to commercially develop and produce this gas.

The recent decline in the natural gas finding rate may be the most significant statistic in assessing prospects for the future. This decline may be seen in the trend of net non-associated reserves added per successful gas well foot drilled shown below.

NET NON-ASSOCIATED RESERVES
DEVELOPED PER SUCCESSFUL FOOT DRILLED
LOWER 48 STATES

<u>Year</u>	<u>Net Reserve Additions (Bcf)</u>	<u>Successful Gas Well Footage (Thousands of Feet)</u>	<u>Finding Rate (Mcf/Foot)</u>
1966	16,136	24,390	662
1967	17,283	20,789	831
1968	12,335	20,117	613
1969	6,875	24,064	286
1970	9,351	22,852	409
1971	8,565	22,609	379
1972	7,597	26,743	284
1973	3,717	35,587	104

These data reflect the impact of the downward revisions to non-associated reserves which have been experienced each year since 1969. The downward trend can still be seen, however, if the finding rate is developed on the basis of total yearly additions to reserves exclusive of revisions. Finding rate data developed in this manner are shown in the tabulation on the following page.

NON-ASSOCIATED RESERVES
DEVELOPED PER SUCCESSFUL FOOT DRILLED
LOWER 48 STATES

<u>Year</u>	<u>Reserve Additions (Bcf)</u>	<u>Successful Gas Well Footage (Thousands of Feet)</u>	<u>Finding Rate (Mcf/Foot)</u>
1966	13,079	24,390	536
1967	13,571	20,789	653
1968	8,298	20,119	412
1969	8,315	24,064	346
1970	9,641	22,852	422
1971	10,037	22,609	444
1972	9,508	26,743	355
1973	9,064	35,587	254

While each of these data series displays a general downward trend over the period considered, it is possible that finding rates could improve in the near future if reported additions are lagging behind reported successful gas well footage or if government policies succeed in eliciting greater supplies than recent historical experience would indicate.

Data developed by the American Association of Petroleum Geologists (AAPG) also show a downward trend. The AAPG classifies new field discoveries by size after examining six years of development history. They have defined as "significant" any gas field containing in excess of 6 billion cubic feet of ultimately recoverable proved reserves. Their data show that the number of "significant" gas field discoveries as a percent of total gas field discoveries is declining, and more importantly the data show that the absolute number of significant gas fields being discovered each year is falling. The number of significant gas field discoveries reached a peak of 99 in 1957 and declined to 41 in 1967, the last year for which six years of development history is available.

**"SIGNIFICANT" GAS FIELD DISCOVERIES
BY YEAR**

<u>Year</u>	<u>Number of Significant Discoveries</u>
1957	99
1958	73
1959	62
1960	80
1961	46
1962	79
1963	50
1964	53
1965	52
1966	47
1967	41

An analysis of FPC Form 15 data pertaining to interstate sources of supply dedicated between 1964 and 1973 has been made which also illustrates the downward trend in the finding rate. These data indicate that while the trend in the number of new sources dedicated annually has been rather flat, the amount of reserves dedicated has declined markedly because the average source size has declined significantly. These trends can be readily seen in the following table and in Figures 1 and 2.

NEW INTERSTATE SOURCES DEDICATED

<u>Year</u>	<u>Number of New Sources</u>	<u>Reserves Dedicated (Bcf)</u>	<u>Average New Source Size (Bcf)</u>
1964	193	4,634	24
1965	158	9,485	60
1966	252	9,564	38
1967	207	8,614	42
1968	155	6,288	41
1969	188	6,216	33
1970	148	3,659	25
1971	164	2,225	14
1972	257	5,040	20
1973	184	1,713	9
Total	1,906	57,436	30

FIGURE 1
INTERSTATE RESERVE DEDICATIONS
FROM NEW SOURCES BY YEAR

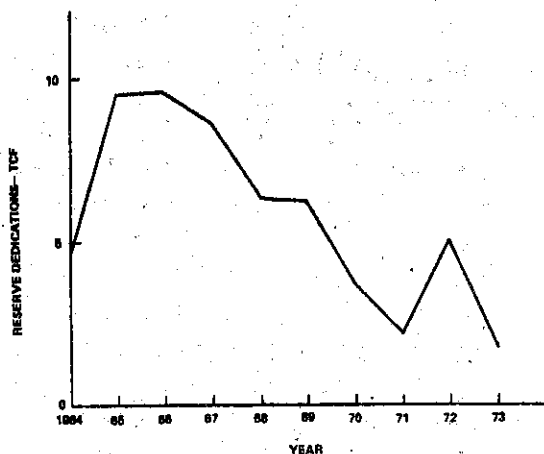
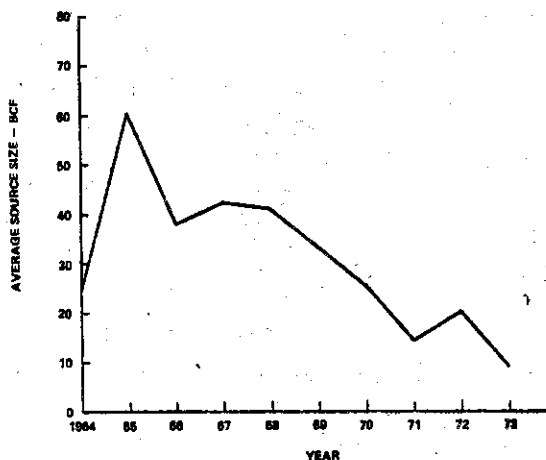


FIGURE 2
AVERAGE SIZE OF NEWLY
DEDICATED INTERSTATE SOURCES



The data cited above do not provide us with information on which we can draw definitive conclusions concerning the size of the undiscovered resource base, one way or the other. Furthermore, the information available does not allow us to determine with certainty if these indicators are related primarily to the size of the resource base or are manifestations of the system under which its development is taking place. These statistics do, however, lend support to the possibility that the undiscovered resource base may actually be much smaller than was previously suspected. Our purpose in raising this issue is not to indicate our support for either camp; it is to focus attention on some very serious questions which have been raised concerning the magnitude of the undiscovered natural gas resource base. Formidable problems lie ahead as the Nation attempts to develop these resources no matter which of the various resource estimates ultimately proves to be most nearly correct. Energy policy makers would be well advised, however, to develop plans and policies keyed to the possibility that the Nation may indeed be experiencing the early effects of a resource being pushed toward exhaustion.

In the sections which follow we will examine some of the production possibilities which result from several assumed levels of future reserve additions. In the light of the resource questions being raised by Moody, Hubbert, Jodry, North and others, we think that those possibilities based on a continuation of recent reserve addition trends take on new meaning.

NATIONAL SUPPLY ANALYSIS

Total U.S. natural gas production increased at an average annual rate of about 7 percent for more than 25 years to 1970. For the three years since 1970 the growth curve has flattened out and preliminary data for 1974 projects a 3 percent decline. Curtailments of firm gas service -- the cutting edge of the gas shortage in practical terms -- started in November 1970 and have risen steadily since then. Curtailments now are substantial in terms of national gas consumption and will increase in the future.

In the discussion which follows we will show the future national gas production that would be available from specific assumed levels of future reserve additions. We will also specify the future reserve additions which would be required to maintain gas production at present levels as well as the reserve additions which would permit low and moderate production growth rates. This section is concerned with total reserve additions and production in the lower 48 states. A subsequent section of this report treats the interstate segment in a similar manner.

Our projections of production are based on a method called the "National Availability Curve" (NAC) that was introduced in the FPC publication National Gas Supply and Demand 1971-1990: Staff Report No. 2, published in February 1972. The curve was developed from over 900 sources of supply (associated, non-associated and dissolved gas) reported in FPC Form No. 15 and was designed to reflect maximum producing rates of the "average U.S. gas source" at every stage of depletion. The forecast method involves segregating total remaining reserves into "vintages" each of which contains the estimated remaining reserves of those additions reported in a particular vintage year. The maximum productive capability for each individual vintage is based on the National Availability Curve. Then the maximum productive capability of the total reserve inventory is determined by summing the maximum productive capability of all the vintages.

The long term prospects for domestic natural gas production through 1985 appear to be worsening at an unexpectedly accelerating pace. Furthermore, the possibilities of sustained

increases in production above the present level appear to be highly unlikely for both the near and long term.

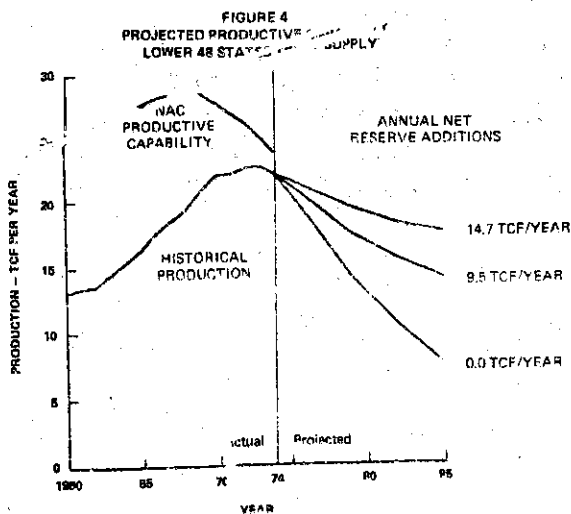
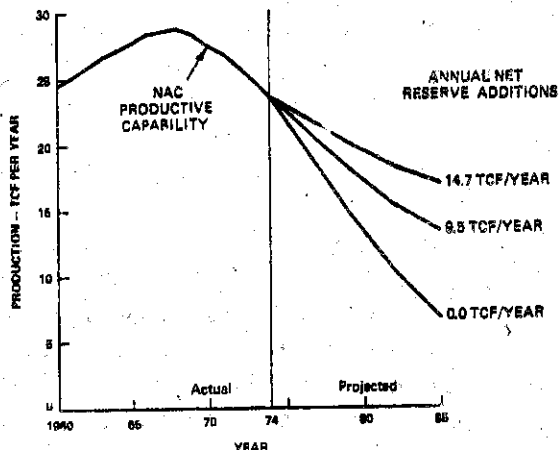
This is shown in Figure 3, where we have utilized the NAC method to plot the theoretical maximum productive capability between 1960 and 1974 and to project productive capability to 1985 under three assumptions of future annual reserve additions:

1. Reserve Additions = 0.0 Tcf,
2. Reserve Additions = 9.5 Tcf, the average since 1968.
3. Reserve Additions = 14.7 Tcf, the average since 1960.

By 1985, projected production under these three assumptions is calculated to be 7.3, 13.8, and 17.4 Tcf, respectively. Thus, even the most optimistic of these projections falls far short of the current level of 22.5 Tcf.

Productive capability derived by the NAC method has been much greater than actual production until the past few years (Figure 4). Productive capability for 1960 was calculated to be 90 percent greater than actual production, but for 1974 it will be only 8 percent greater.

FIGURE 3
NAC PRODUCTIVE CAPABILITY
LOWER 48 STATES TOTAL SUPPLY



The occurrence of a gap between actual production and computed productive capability is logical for the past, when an abundance of supply was available. It is also understandable now, even though curtailments are being experienced. One reason for the gap at the present time is that some pipeline companies are in reasonably satisfactory supply situations as compared to others.

and are not required to draw on their reserves at maximum rates all of the time. Also, some reserves are in shut-in status awaiting a pipeline connection, a contract commitment, or for other reasons. Forecasts of production are premised on a diminishing gap between actual production and productive capability until 1985, at which point they are set equal. The 1985 production forecasts, therefore, might be considered slightly high because it is likely that some portion of the reserve inventory, particularly offshore, will be in non-producing status at any particular time.

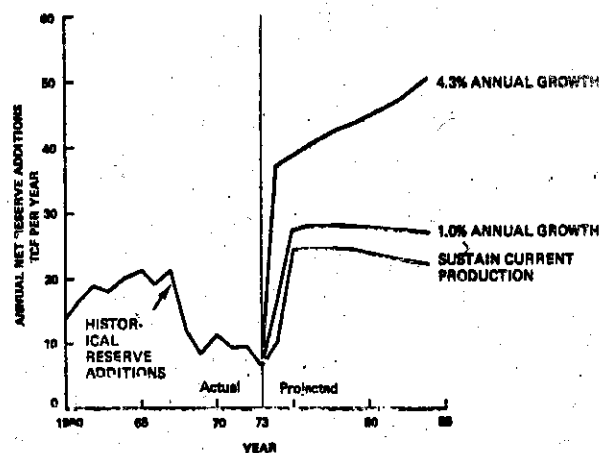
Figure 4 also depicts our projections of productive capability to 1985 adjusted to reflect the difference between calculated productive capability and actual production experience. The assumption of no future reserve additions is of course unrealistic, but illustration and discussion of this case serves two purposes. First it forecasts the production that is available from the 1973 proved reserve inventory, and second it serves as a base case forecast, a lower limit to the range of possibilities. Under assumption 1, production would plummet beginning now and continuing through 1985 at an average annual rate of decrease of 9 percent annually.

A realistic forecast of gas production requires some accounting for new reserves to be added. Reserve additions during the period 1968-1973 have averaged 9.5 Tcf in the lower 48 states. Our second assumption considers what the future reserves inventory could produce based on projected annual reserve additions of 9.5 Tcf, which can be viewed as a continuation-of-present-trends forecast. We feel the chances for this level of additions are reasonably good. We estimate that natural gas production in this instance would fall an average of 4 percent a year to 1985 when production would be 13.8 Tcf.

Our third projection considers a forecast of annual reserve additions equal to the average since 1960, 14.7 Tcf per year, a rate approximately one and one-half times higher than our projection under a continuation of current trends. In this case domestic gas production would fall an average of 2 percent per year, reaching 17 Tcf in 1985.

Our NAC procedure was also utilized to estimate what schedule of reserve additions would be necessary to keep production at the 1973 level of 22.5 Tcf. As shown in Figure 5 we estimate that in order to hold production at the 1973 level, annual reserve additions must rise to the 22-24 Tcf range by 1975 and then remain at that level. As favorable as the production would be in comparison to the previous projections, it is improbable that new reserve additions will be high enough, in view of the performance of the industry over its entire history to date and particularly in view of its performance over the last six years.

FIGURE 5
REQUIRED NET RESERVE ADDITIONS
LOWER 48 STATES TOTAL SUPPLY

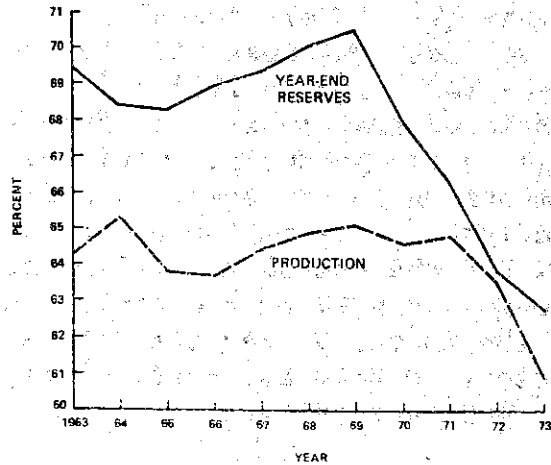


To complete our analysis we illustrate what reserve additions would have to be discovered in order to permit production to continue to grow. Lower 48 states gas production has increased at an average rate of 4.3 percent per year since 1960. Attainment of this rate of increase in annual production would require abnormally high reserve additions which would have to jump immediately to nearly 40 Tcf and continue growing at 1.2 Tcf per year (Figure 5). A more modest production growth rate goal might be 1.0 percent per year which was experienced between 1970 and 1973. In this case, the required annual reserve additions would have to average approximately 27 Tcf each year in the future, also an unlikely eventuality in view of past history.

INTERSTATE SUPPLY ANALYSIS

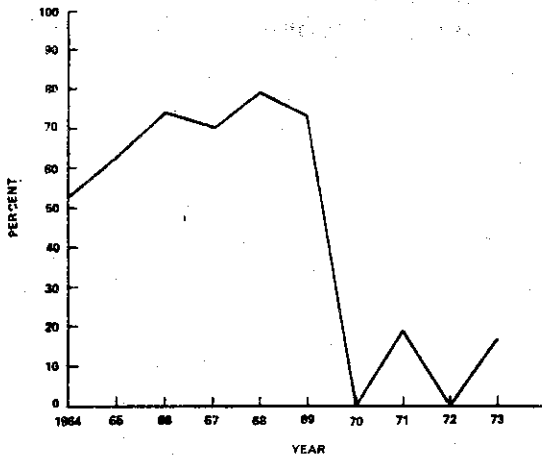
Interstate production peaked in 1972 at 14.2 Tcf and represented 63 percent of total lower 48 state production. Proved reserves dedicated to interstate pipelines peaked in 1967 at 198.1 Tcf and comprised 69.3 percent of the lower 48 state proved inventory. Since 1969, interstate production and reserves have each been dropping as a percent of total lower 48 state production and reserves as shown on Figure 6. During this same period annual interstate reserve additions as a percent of national reserve additions declined as shown on Figure 7.

FIGURE 6
INTERSTATE PRODUCTION AND RESERVES AS A
PERCENT OF NATIONAL PRODUCTION AND RESERVES



Thirty-two states, including most of the large heavily industrialized states, are dependent on interstate gas for at least 90 percent of their total gas supply. Nineteen of these states are totally dependent on interstate gas. The pattern of gas consumption in the gas producing states is different from that seen in the states which rely on interstate supplies of gas. For example, residential and commercial uses of gas account for only 11.7 percent of total gas use in the major producing states but account for 48.0 percent of total gas use in all the other states which are served by the interstate pipeline network.

FIGURE 7
INTERSTATE NET RESERVE ADDITIONS
AS A PERCENT OF NATIONAL NET
RESERVE ADDITIONS



The gas supply position of the interstate market is weaker than for the nation as a whole. In 1973 annual interstate production was 13.7 Tcf and year-end 1973 interstate proved reserves stood at 134.3 Tcf. This was a drop of 32.2 percent from the interstate reserve peak of 1967 and a

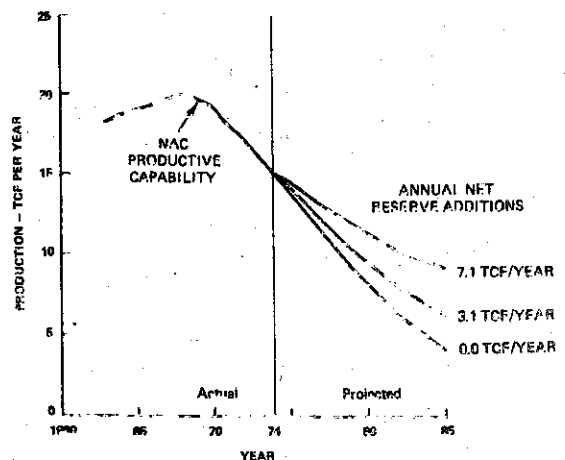
3.7 percent drop in interstate production from the prior year, the first time that production has decreased during the 35 year history of continuous growth enjoyed by the modern interstate pipeline system.

Curtailments of firm service were first experienced in November of 1970 and have steadily risen to 1.1 Tcf in 1973 when they amounted to about five percent of total U.S. production. Preliminary estimates indicate that curtailments will now reach approximately 2 Tcf in 1974 and that for the 1974-1975 heating season they may be as much as 107 percent higher than for the prior year's heating season.

We have applied the National Availability Curve (NAC) to the interstate sector under various reserve addition assumptions in the same fashion as our analysis of national supply. If we assume a continuation of interstate reserve additions at the level experienced over the past six years (3.1 Tcf per year), then interstate production can be expected to drop at an average of 5.6 percent per year between now and 1985. Reserves and production under such a schedule would fall to 55.1 Tcf and 6.8 Tcf, respectively, in 1985. It is abundantly clear that present production simply cannot be sustained at the current level of reserve additions.

A projection based on a longer history of interstate reserve additions does not offer much more encouragement. Reserve additions since 1964 (the earliest date for which we have interstate data) have averaged 7.1 Tcf per year. Even under these conditions we estimate that production would decline about 3.0 percent per year and would amount to about 9.6 Tcf in 1985, a 32 percent drop from the 1972 peak production year. Actually this forecast is fundamentally optimistic because our assumption of annual reserve additions of 7.1 Tcf anticipates the interstate companies receiving about 48 percent of the total national reserve additions. This is most unlikely if recent trends continue. Interstate pipeline companies have acquired only about 8 percent of

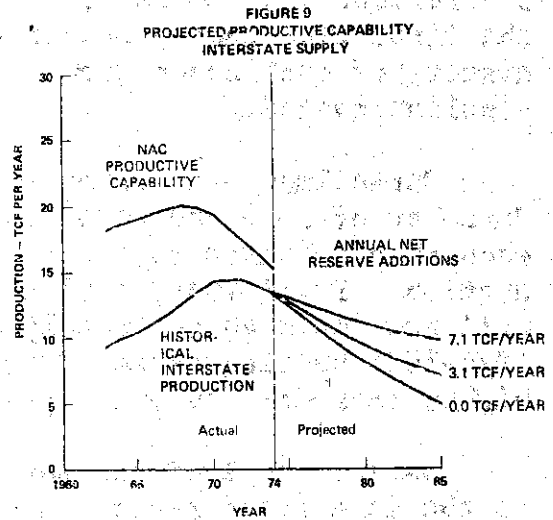
FIGURE 8
NAC PRODUCTIVE CAPABILITY
INTERSTATE SUPPLY



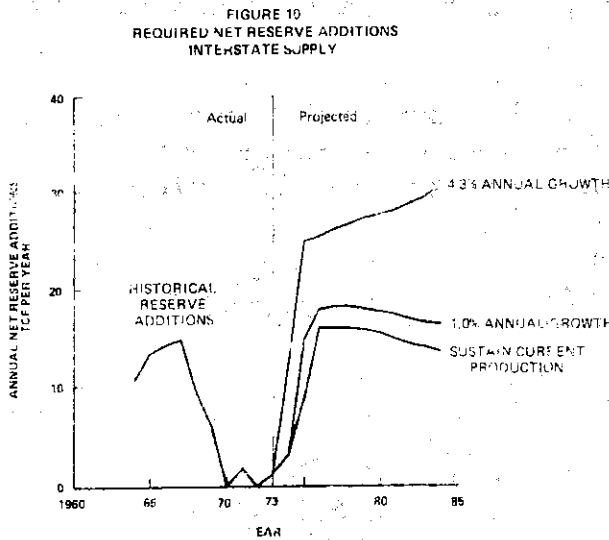
the national reserve additions over the last four years.

An assumption of zero reserve additions to interstate supply yields a maximum production of only 4.8 Tcf for 1985. The application of NAC to these three interstate cases is shown on Figures 8 and 9.

The level of reserve additions necessary to hold production level or provide for growth in annual production of one percent and 4.3 percent are depicted on Figure 10. None of these expectations appear to be realistic. For example, the attainment of a one percent growth in interstate production requires interstate reserve additions to jump within two years to 17.9 Tcf, more than two and one-half times the national



requires interstate reserve additions to jump within two years to 17.9 Tcf, more than two and one-half times the national reserve additions of 6.5 Tcf in 1973.



INTRASTATE GAS SUPPLY

We have looked at interstate gas supply in some detail. The other segment of total supply is intrastate supply-- the gas that is used in the same state in which it is produced and which is equivalent to about one-third of lower 48 state gas use. As we have noted, since 1968 the interstate supply system has been receiving a smaller fractional share of total new gas supply than it did in the years prior to 1968. Conversely, the intrastate sector appears to have been relatively stable in recent years and is now receiving a larger fractional share of total new supply than in the past.

We do not have information on the reserve additions acquired by the intrastate gas companies or on new reserves set aside by producers for their own purposes. In the absence of such data we have assumed that all of the new reserves reported by AGA not committed to the interstate pipelines are being committed to the intrastate gas market. It thus appears that the intrastate gas market is enjoying a relatively favorable gas supply position in spite of the disappointing record for national discoveries and reserve additions. It would seem from the information shown on Table 1 that the intrastate market has had net reserve additions

TABLE 1
LOWER 48 STATE
NET RESERVE ADDITIONS
INTERSTATE VS. INTRASTATE

Year	Total Net AGA Reserve Additions	Net Interstate Reserve Additions (Form 15)		Inferred Intrastate Reserve Additions ^{1/}	
	Tcf	Tcf	Percent	Tcf	Percent
1964	20.1	10.6	53	9.5	47
1965	21.2	13.3	63	7.9	37
1966	19.2	14.2	74	5.0	26
1967	21.1	14.8	70	6.3	30
1968	12.0	9.5	79	2.5	21
1969	8.3	6.1	73	2.2	27
1970	11.1	0.0	0	11.1	100
1971	9.4	2.0	21	7.4	79
1972	9.4	(0.2)	0	9.6	100
1973	6.5	1.1	17	5.4	83

^{1/} Derived by assuming that intrastate reserve additions are equal to the difference between total AGA reserve additions and the reserve additions committed to the interstate market.

averaging 3.4 Tcf per year for the four years 1970-73 as compared with an average of 5.6 Tcf per year for the prior six year period 1964-69. This is in sharp contrast to the recent reserve addition experience for interstate supply where average annual net reserve additions for the 1970-73 period were only about 0.7 Tcf as compared with approximately 11.4 Tcf for the 1964-69 period. The disparity between the recent net reserve addition records of the two gas industry components is also shown on Figure 11. Table 2 shows trends similar to those seen in Table 1 even though the second table is based on total annual additions to reserves exclusive of revisions. These data would indicate that, to a degree, the recent relative advantage of the intrastate sector has been at the expense of interstate supply.

FIGURE 11
AVERAGE ANNUAL NET RESERVE ADDITIONS
INTERSTATE AND INTRASTATE

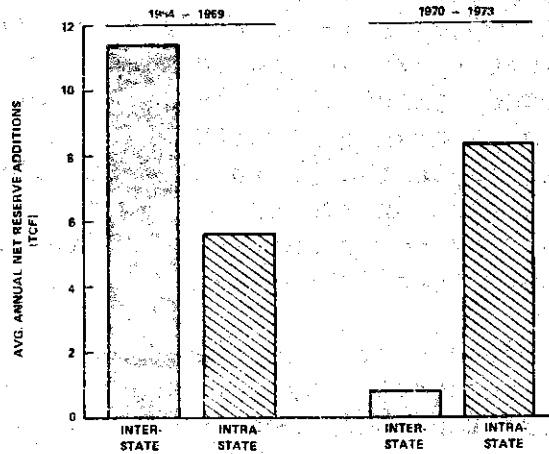


TABLE 2
LOWER 48 STATE
TOTAL RESERVE ADDITIONS
INTERSTATE VS. INTRASTATE

Year	AGA Reserve Additions Excluding Revisions Tcf	Interstate New Supply (Form 15)		Inferred Intrastate New Supply ^{1/}	
		Tcf	Percent	Tcf	Percent
1964	N.A.	4.9	-	-	-
1965	N.A.	10.4	-	-	-
1966	14.8	10.0	68	4.8	32
1967	14.8	9.9	67	4.9	33
1968	9.8	6.4	65	3.4	35
1969	9.6	6.2	64	3.4	36
1970	11.3	3.5	31	7.8	69
1971	11.1	2.2	20	8.9	80
1972	10.7	5.0	47	5.7	53
1973	10.1	1.7	17	8.4	83

^{1/} Derived by assuming that intrastate reserve additions are equal to the difference between total AGA reserve additions and the reserve additions committed to the interstate market.

N.A. - Not Available

Further evidence of the present favorable gas supply situation of the intrastate gas market can be seen in a comparison of recent changes in the proved reserve inventory of the interstate and intrastate components of the gas industry. Whereas the interstate proved reserve inventory has declined 28.8 percent from 1963 to 1973, the intrastate proved reserve inventory has remained at approximately the same level. This can be seen in Table 3.

TABLE 3
LOWER 48 STATE
YEAR-END RESERVES
INTERSTATE VS. INTRASTATE

Year	Total AGA Reserves <u>1/</u>	Interstate Reserves (Form 15)		Inferred Intrastate Reserves <u>2/</u>	
	Tcf	Tcf	Percent	Tcf	Percent
1963	271.7	188.5	69	83.2	31
1964	276.5	189.2	68	87.3	32
1965	281.4	192.1	68	89.3	32
1966	283.2	195.1	69	88.1	31
1967	285.9	198.1	69	87.8	31
1968	278.6	195.0	70	83.6	30
1969	266.3	187.6	70	78.7	30
1970	255.6	173.6	68	82.0	32
1971	243.1	161.3	66	81.1	34
1972	230.2	146.9	64	83.3	36
1973	214.2	134.3	63	79.9	37

1/ Excludes gas volumes in underground storage.

2/ Derived by assuming that intrastate reserves are equal to the difference between AGA reserves and reserves reported in Form 15.

.CONCLUSIONS

A significant point that emerges from our analysis is that conventional U.S. gas production has reached its peak and will be declining for the indefinite future. This reverses a long historical record of growth and introduces a new dimension to the gas shortage. It is no longer simply a matter of gas supply failing to meet increasing requirements. It means that from here on we must make do with less gas in absolute terms. We see this as inevitable regardless of the size of the U.S. undiscovered natural gas resource base. However, the unresolved question concerning the extent of our undiscovered resource base has a direct bearing on the rate at which future production will decline. The Federal government should therefore immediately undertake, or sponsor, an objective, in-depth examination of this matter in order to develop more reliable information in this critical area.

In our review of future gas supply possibilities we have not offered any firm predictions for the future. Policy makers would be well advised, however, to consider the realities of the recent past and to develop plans accordingly. The facts as they relate to the gas shortage and to future supply prospects have been abundantly clear for some time. Past efforts to effect a turnaround in the National supply posture have been largely ineffective and we view the likelihood of success in the future with pessimism. Curtailments of natural gas service are now starting to pinch the economy and affect citizens in their daily lives. Further studies, surveys and analytical exercises will undoubtedly underscore and refine what we already know about the critical aspects of the gas shortage. But we must move immediately and aggressively to implement programs which will reduce the economic impacts associated with continuing gas supply deficiencies.

This effort should, of course, include actions designed to create a new sense of urgency and provide greater impetus to the development of supplemental supply sources and to the development of conventional natural gas resources, particularly in the frontier areas. Nevertheless, even these accelerated efforts will not provide the basis for a continuation of conventional production at present levels. Programs designed to cope with declining production and to ameliorate the consequences

of increased reliance on supplemental supplies must therefore include:

- o Mandatory natural gas conservation measures by Federal, State and local jurisdictions, for all uses of gas, including residential.
- o Allocation of gas by Federal, State and local jurisdictions to high priority end uses, such as residential, small commercial and essential petrochemical and specialized industrial uses for which no other fuel is available.

The hour is very late. The time for action is now.



APPENDIX B

SUMMARIES OF COST ESTIMATES OF NATURAL GAS DEREGULATION

This appendix is reproduced from the report of the Intra-agency Task Force of the Federal Power Commission of January, 1975, entitled: "A Preliminary Evaluation of the Cost of Natural Gas Deregulation." The material appeared as an appendix in the FPC report as well.

The appendix summarizes a number of studies that have been performed estimating the cost and impacts of deregulation. It is preceded by a table comparing some of the conclusions of these studies.

The FPC Task Force cautioned readers to obtain the details of each summarized study from the study itself, because considerable information was omitted in condensing the various efforts. That caution is repeated here.

Nonetheless, the FPC Task Force has done a good job of pulling its conclusions and basic reasoning, from each attempt to judge the costs of deregulation. A few minutes spent reviewing this appendix can materially assist one without absorbing the time required to read the original studies.

Summary Of Studies

This section provides an information summary and overview of the cost and economic-social impacts as developed in recent studies relating to the deregulation of natural gas. Task Force Table No. B-1 compares the salient features of the various studies.

The reader is cautioned to obtain the details of the data presented in Table No. B-1 from summaries of each study in the text of this report and the actual studies. Considerable information has been omitted in an attempt to construct a relatively simple comparative table.

Task Force Table No. B-1
 Summary of Selected Conclusions of Various
 Natural Gas Deregulation Schedules a/

Deregulation Study	Extent of Deregulation	Time Period Covered by Study	Free Market Price <u>b/</u> of New Gas at Wellhead Assumed in Calculations <u>c/</u> Mcf	Average Wellhead Price <u>c/</u> Mcf			Cumulative Increased Cost to Consumer Billion \$		Total Production Tcf	
				Initial Year of Study	1975	Final Year of Study	Specified Year	Entire Study Time Period	Specified Year	Final Year of Study
Foster - API	All sales <u>c/</u>	1974-80	\$.75 <u>d/</u>	29.5	34.8	57.3	\$0.93 <u>g/</u> (1974)			
Schwartz	New gas	1975-80	\$.75 - \$1.25				\$9.2- 11.2 (1975)	\$54 - 58	22.5 (1975)	22.5
Dept. of the Interior EIS	Total deregulation (medium case)	1973-85		38.0	48.0	42.0			18.7 (1975)	22.0
Project Independence	New gas	1974-85	\$1.00 <u>f/</u>						16.7 <u>h/</u> (1974)	21.3
Kumins - Library of Congress	Total deregulation <u>e/</u>	1974-80	\$1.75				\$7.1 (1974)	\$75.6		
Helms	Total deregulation	1972-80		27.5	30.3	33.7			28.3 (1975)	28.7
Breyer & MacAvoy	Total deregulation	1961-68		20.0 (1961)		27.8 (1968)				
Erickson & Spann	Total deregulation	1972-85		43.5	51.8	92.9				
MacAvoy & Pindyck	Phased deregulation	1972-80		39.7	52.8	34.1			26.8 (1975)	35.0

- a/ Some columns are blank for each study because the study did not attempt to make a projection for those items.
b/ In most studies where a wellhead price for new gas was assumed, an average wellhead price was not an output of the study. The Foster study is an exception.
c/ The Foster study has 4 deregulation cases. The one used for this table is all sales.
d/ The Foster study also makes projections based on 45¢, 55¢, and 65¢.
e/ The Kumins study has 2 deregulation cases. The one used for this table is complete deregulation.
f/ The Project Independence study also makes projections based on other prices ranging from 40¢ to \$2.00.
g/ The increased annual cost to the residential consumer at the wellhead free market price of 75¢ per Mcf is \$18.82 in 1975 and \$48.28 in 1980.
h/ Nonassociated production.

Economic Impact Report on
Deregulation of Natural Gas
Lawrence Kumins

This study evaluates the economic impact on consumers of natural gas price increases which would stem from deregulation legislation. The following is a summary of its findings:

- (a) Assuming that, under deregulation, gas prices converge on an oil parity price of \$1.75 per Mcf in a free nationwide market, full deregulation will cost \$7.1 billion at the end of the first year and, if deregulation occurred today, cumulative costs would be about \$75.6 billion at the end of 1980.
- (b) New gas deregulation would have a first year cost of \$5.4 billion. Assuming deregulation today, cumulative costs would be \$59.9 by 1980.

Basic to the above calculations is the \$1.75 per Mcf estimate of the free market price of gas. This estimate was based on \$12 per barrel oil divided by the Btu's in a barrel of oil times the Btu's in an Mcf of gas ($\$12 \div 5.8$ million Btu's x 1 million Btu's). The result, approximately \$2.10 minus an estimated pipeline transportation cost of 34¢, comes to approximately \$1.75. Although this is the figure the author uses in his calculations, he cautions that because the estimate is made in relationship to the lowest cost grade of fuel oil and because gas is a premium fuel, the price of gas could actually be higher.

Mr. Kumins states that although supporters of deregulation claim that the price increase resulting therefrom will encourage significant additional production, the question of the exact volume of such production has never been realistically addressed. Upon deregulation he estimates a zero increase in production or a decrease.

Mr. Kumins estimates that if deregulation increases the interstate supply of gas by 2.4 Tcf (20%) such incremental gas supply should bear the full cost of deregulation, which is estimated to be \$17.7 billion at the end of the sixth year, since this additional supply is the only reason why gas has been deregulated. The marginal cost of this gas is \$7.40 per Mcf.

He states that since there is little evidence to suggest that the supply of gas would be increased by raising prices, it would be more meaningful to link higher prices with increased production levels. By doing this only increased production would be rewarded directly, providing a meaningful incentive for increased exploration without having that incentive financed by consumers.

With respect to intrastate prices, it is suggested that research in this area might be worthy of legislative attention because an exact determination of these prices would help clear up some of the confusion surrounding the dichotomy between the regulated and unregulated sectors.

The elements of the increased cost of both complete deregulation and deregulation of new gas only are shown in the attached Task Force Table No. B-2.

The study also assesses the consumer cost impact of unregulated gas price increases which are directly attributable to post-embargo oil prices and arrives at a current price of \$5.78 billion and a price of \$12.6 billion by mid-1975. 1/

-
- 1/ The data used to arrive at these prices is as follows:
- (a) 10.5 Tcf of production is unregulated.
 - (b) The pre-embargo intrastate price of gas is estimated at 55¢ per Mcf.
 - (c) The current intrastate price of gas is estimated at \$1.10 per Mcf.
 - (d) The 1975 price of intrastate gas is estimated to be \$1.75 per Mcf.
 - (e) Calculation for current price of intrastate gas
10.5 Tcf x (1.10 - 55¢) = \$5.78 billion
 - (f) Calculation for 1975 price of intrastate gas
10.5 Tcf x (\$1.75 - 55¢) = \$12.60 billion

Task Force Table No. B-2

The Cost of Complete Deregulation and New Gas Deregulation

A. First Year Price Effect of Complete Deregulation

<u>Type of Contract</u>	<u>Increase in Cost of Gas</u>
1. Flexible pricing contracts	\$1.29 billion
2. Expiring Contracts	2.65 billion
3. Short term and emergency sales	1.02 billion
4. Contracts with upward flexibility	.20 billion
5. Renegotiated contracts already having price flexibility	.56 billion
6. Renegotiated fixed contracts	<u>1.38 billion</u>
First Year Cost of Complete Deregulation	\$7.10 billion

B. Annual Cost of Complete Deregulation Over a 6-Year Period

End of year 1	\$ 7.1 billion
End of year 2	9.7 billion
End of year 3	11.7 billion
End of year 4	13.7 billion
End of year 5	15.7 billion
End of year 6	<u>17.7 billion</u>
Cumulative Cost of Complete Deregulation at End of 6 Years	\$75.6 billion

C. First year Price Effect of New Gas Deregulation 1/

<u>Type of Contract</u>	<u>Increase in Cost of Gas</u>
1. Short term and emergency sales	\$1.02 billion
2. Expiring contracts	2.65 billion
3. Contracts containing renegotiation clauses 2/	<u>1.76 billion</u>
First Year Cost of New Gas Deregulation	\$5.43 billion 3/

1/ Includes flowing gas released from expired contracts and gas deliveries for the first time to the interstate market.

2/ One-half of these contracts are assumed to be renegotiated at a Commission approved price averaging an estimated 65 cents per Mcf.

3/ The author states that in 5 or 7 years the annual cost of new gas deregulation will be approximately \$17.7 billion, the annual cost of full deregulation

Final Environmental Impact Statement,
Deregulation of Natural Gas Prices
U. S. Department of Interior

The objective of the Statement was to determine the various socioeconomic and environmental impacts associated with the deregulation of natural gas prices. In determining the various impacts, Interior considered a variety of issues concerning natural gas, including the environmental impact of deregulation and the possible effect upon competing rival fuels.

Interior states that the impact of deregulation on production and consumption of natural gas and substitute fuels is extremely difficult to predict. Most likely, deregulation will result in both prices and consumption attaining higher levels than would be the case under continued regulation.

In order to evaluate the impact of deregulation of natural gas prices, a parametric 1/ computer model of supply-demand interactions was constructed and used in an effort to provide a means of evaluating the market impacts of wellhead price deregulation. The model provides projections which must be attempted if a reasonable assessment of the impact of deregulation is to be made.

1/ The user of the model must specify the parameters, or boundaries, which he thinks likely to describe market behavior under deregulation.

One of the key variables of the USDI model is supply-demand elasticities. 2/ For example, the residential sector use may be less elastic than the industrial sector, while the demand elasticity of various industries may also differ. The technique employed for the model is one of comparative statics.

2/ Elasticity is briefly explained as follows: "A "demand curve" is a line on a Y-X coordinate system of the quantity of a good (in this case gas) which a consumer is willing to buy, as a function of price. Demand is represented as a line curving down from left to right with price represented on the vertical axis with quantity on the horizontal axis of the graph. As prices go up, the consumer is willing to buy less; therefore the curve goes down and to the right. The ratio of a percentage change in the quantity demanded to a percentage change in price is called the demand elasticity of the good. The supply curve is represented by a line curving up from left to right. As a producer is willing to supply more at higher prices, his curve goes up and to the right. Similarly, the elasticity of supply is represented by a ratio of the percentage change in the quantity supplied to a percentage change in price.

Given this description of elasticities, the elasticity values selected by Interior can be explained thusly: Assuming a shifting supply and demand schedule towards an equilibrium point, the supply and demand elasticities will change accordingly. In order to capture this shifting effect, Interior selected the values .1 to 1.0. Additionally, the supply-demand elasticities were based on estimates derived in past empirical studies.

The variables selected for the model are given in Task Force Table No. B-3.

The parametric model was used for combinations of supply elasticities ranging from 0.1 to 1.0 and demand elasticities ranging from minus 0.1 to minus 1.0. Three sets of supply and demand elasticities were selected as representative of those which would result in low, medium and high estimates of natural gas production and consumption. They are:

<u>Estimate</u>	<u>Demand Elasticity</u>	<u>Supply Elasticity</u>
Low	-1.0	0.3
Medium	- 0.5	0.5
High	- 0.3	0.7

The results are shown in the following Task Force Table No. B-4.

Task Force Table No. B-3.

(Page 1 of 2)

Variables in the Model of Market Response to Price Rise

<u>Variables</u>	<u>Values Adopted in Runs Reported</u>	<u>Values Tested but Not Reported</u>
Long-run demand elasticity	-0.1 to (-1.0) *	--
Long-run supply elasticity	0.1 to 1.0*	--
Demand response rate	50% in 3 years 100% in 8 years	50% in 5 years 100% in 8 years
Supply response rate	50% in 7 years 100% in 10 years	50% in 3 years 100% in 8 years
Annual gas demand increase rate	0.06	0.042
Reserve drawdown	10, 5, 2.5, 0 ...	10, 10, 0, 0 ... (and subject to R/P constraint)
Reserve/Production constraint	R/P = 10.0, but additions total 20% of gap	R/P \geq 10.0, 8.0; none; 33-1/3% of gap
Imports (see schedule, Table II-5)	1.1 - 1.9 TCF per year	--
Time horizon	13 years	--
Demand, 1972 (FPC, 1972a)	26.1 TCF	--
Supply (equals additions to reserves) available at 1972 prices (FPC)	14.0 TCF	--
Price, 1972 (USBM)	\$0.196/MCF	--
<u>Total reserves at end of 1972 (FPC)</u>	238.0 TCF	--

*For full range of outcomes, see Appendix B to Final Environmental Impact Statement, Deregulation of Natural Gas Prices. Source: Final Environmental Impact Statement, Deregulation of Natural Gas Prices, U. S. Department of Interior, Table II-4.

Task Force Table No. B-4.

Average Equilibrium Prices, Reserve Additions, Production, Quantity Consumed
and Year End R/P Ratios Under Assumed Ranges of Long Run Elasticities
(1973-1985)

Year	Imports	HIGH (D = -0.3; S = 0.7)					MEDIUM (D = -0.5; S = 0.5)					LOW (D = -1.0; S = 0.3)				
		Price	Res. Add.	Prod.	Consump.	R/P	Price	Res. Add.	Prod.	Consump.	R/P	Price	Res. Add.	Prod.	Consump.	R/P
1973	1.1	\$0.44	14.87	24.87	25.87	9.2	\$0.38	14.46	24.46	25.56	9.3	\$0.30	14.16	24.16	25.26	9.4
1974	1.1	0.62	16.99	21.99	23.09	10.1	0.50	15.57	20.57	21.67	10.8	0.37	14.54	19.53	20.63	11.4
1975	1.2	0.59	18.17	20.67	21.87	10.7	0.48	16.17	18.67	19.87	11.8	0.36	14.73	17.23	18.43	12.8
1976	1.3	0.59	19.67	19.67	20.97	11.2	0.49	16.97	16.97	18.27	13.0	0.36	15.01	15.01	16.31	14.7
1977	1.4	0.55	20.32	20.32	21.72	10.9	0.46	17.32	17.32	18.72	12.7	0.34	15.13	15.13	16.53	14.6
1978	1.5	0.52	20.92	20.92	22.42	10.5	0.43	17.63	17.63	19.13	12.5	0.33	15.23	15.23	16.73	14.5
1979	1.6	0.50	21.49	21.49	23.09	10.3	0.42	17.91	17.91	19.51	12.3	0.32	15.33	15.33	16.93	14.4
1980	1.7	0.46	22.91	22.91	24.61	9.6	0.40	18.75	18.75	20.45	11.8	0.31	15.63	15.63	17.33	14.1
1981	1.8	0.47	25.47	23.75	25.55	9.4	0.40	19.93	19.93	21.73	11.1	0.31	16.08	16.08	17.88	13.7
1982	1.9	0.48	27.96	24.90	26.80	9.1	0.40	21.11	21.11	23.01	10.4	0.31	16.54	16.55	18.45	13.3
1983	1.9	0.50	29.27	24.52	26.42	9.4	0.40	21.42	21.42	23.32	10.3	0.32	16.63	16.63	18.53	13.3
1984	1.9	0.50	29.22	26.19	28.09	8.9	0.41	21.71	21.71	23.61	10.2	0.32	16.71	16.71	18.61	13.2
1985	1.9	0.53	30.85	25.09	26.99	9.5	0.42	22.00	22.00	23.90	10.0	0.33	16.79	16.79	18.69	13.1

Source: Final Environmental Statement, Deregulation of Natural Gas Prices, Table II-5.

As indicated by the Interior, forecast market conditions vary widely on the time period analyzed (1973-1985). Interior notes that long run supply and demand elasticity values are the major factors influencing price and quantity forecasts. Nevertheless, conclusions drawn by Interior note, that from a general view of the results, prices tend to rise at the beginning of the period analyzed and then fall gradually to a long run equilibrium level. Similarly, quantities consumed fall at the beginning of the period and then recover at various rates depending upon the elasticity values. Interior stresses that the variation in the rate of price and quantity change are heavily dependent on the elasticity values selected.

Selected Socio-economic Impacts

The direct economic impacts of deregulation projected by Interior include: (1) increased supplies (2) increased prices at the wellhead, and (3) higher fuel bills to direct consumers of natural gas ^{3/} in general, at the beginning of the period analyzed.

Other impacts projected by Interior include higher prices of goods or services to which gas is an important input, and altered patterns of use of natural gas and other energy forms.

Respecting possible alteration in fuel use patterns, Interior suggested that (1) deregulation would cause some shift in consumption from the intrastate to the interstate market; (2) this shift, together with the rise in prices, would cause a larger fraction of gas to be consumed by the household (and perhaps commercial) sector, and a smaller fraction by the industrial and utility sectors; and (3) as a result, some industrial and utility users would switch to alternative fuels-- notably coal and oil.

Interior further stated that deregulation of natural gas prices could operate to force expensive supplemental source of gas, such as imported LNG, and synthetic gases, from the market, but a more likely result would be the reduction of the consumption of such supplemental forms of energy. Since LNG and liquid feedstocks used in synthetic natural gas production are largely

^{3/}With respect to higher fuel bills, the statement does point out that deregulated natural gas may displace higher priced synthetic or LNG. Thus, the rise in consumer price due to deregulation may not be significantly higher than the rise which would be due to increased use of supplementary sources under continued regulation.

imports, a reduction in dependence upon foreign fuel sources would benefit the economy by lowering the balance of payments deficit.

The fertilizer industry is cited as an example of an industry that could be significantly affected by increased natural gas prices as a result of deregulation. Such price increases could affect the economies of ammonia production to the extent that it would be more economical to produce ammonia in countries where natural gas would be less costly. This could result in the U. S. becoming dependent upon imported ammonia for nitrogen fertilizer, as well as imported urea for urea based fertilizers. This, in turn, could exert a major impact on our nation's food supply and economy.

Environmental Impacts

A number of probable direct environmental impacts of deregulation are identified by the Interior study, primarily those associated with the exploration, development, and production of natural gas, such as the pre-emption of land use, the hastening of erosion, loss of vegetative cover, water and air pollution, interference with animal life, and the possibility of subsidence and earthquake when gas and fluids are withdrawn from underground reservoirs. Such activities can also lead to impacts on human health and safety, as well as on aesthetic, archaeological and historic values.

The Interior statement suggests that the overall environmental impact of deregulation may be less than under continued regulation. This aggregate impact depends strongly on the extent to which gas called forth by deregulation displaces other fuels. Natural gas production under deregulation is not expected to substantially exceed current levels; but it is expected to be significantly higher than that expected under continued regulation. Thus, it is projected that deregulation will lead to some displacement of fuels whose extraction and use cause greater insults to the environment than is the case with natural gas.

The Impact of Deregulation on Natural Gas Prices
(Report for American Petroleum Institute
by Foster Associates, Inc., August 1973)

The main subject of this study is the possible impact of several types of deregulation 1/ on natural gas field prices and on future costs to residential consumers.

Inasmuch as prices negotiated in an unregulated market cannot be known, Foster presents four alternative market price levels ranging from 45¢ to 75¢ per Mcf. 2/ These prices are then projected against a detailed analysis of 1,471 contracts, which accounted for 70% of all interstate sales in 1971.

According to Foster the 1972 average annual bill of a residential consumer amounted to \$155.73. With total deregulation, Foster finds that the cost would increase on 1-1-75 by \$12.96 using the 55¢ field market price assumption and by \$15.89 using the 75¢ field market price assumption. These increases reflect both the higher prices for new supplies under future contracts and the projected increases in producer revenue for deliveries made under existing contracts. The price impact increases over time, but Foster states that as of 1980 the annual dollar increment will amount to only 7-13 percent of the average 1972 expenditures by residential consumers. 3/

1/ Deregulation of all sales, deregulation of new sales and existing contracts, phased deregulation and deregulation of new sales only. Phased deregulation, in the context of this report, assumes that contracts which expire by their own terms would be deregulated at the date of contract termination and sales under contracts still in effect would be deregulated by phases over a four-year period.

2/ The results of the 45¢ study are not discussed herein,

3/ The Foster estimates refer only to gas under contract as of 1-1-73.

This report asserts that increases in costs to residential consumers would be gradual, averaging 2.8% per year to 1980 at the 55¢ base level and 3.4% per year at the 65¢ base level. Also, the increase in residential burner tip prices corresponding to any given increase in field price is relatively small because the prices received by producers represent only one-sixth of the price paid by the residential consumers since transportation and distribution costs account for five-sixths of the consumer expenditure.

Foster also discusses the supply-price relationship, concluding that research to date (August 1973) has not yielded reliable measures of the price-elasticity of natural gas supply.

Finally, Foster examines the costing of exploration and development of new gas supplies, concluding that although future cost trends of providing and developing gas supplies will be dependent in part on changes in price levels in the economy generally, the future trend in the cost of gas is upward because gas is a limited resource and natural gas production is inherently an increasing cost industry.

Appendix A, Tables 1-4, and 8 of the Foster study show the estimated future prices, assuming partial or complete deregulation, for gas supplies committed under contracts prior to January 1, 1973, based on contract-by-contract analysis. Selected excerpts from Tables 1, 3 and 4, as well as Table 6, of the Foster study which reflects the revenue impact of deregulation of new sales only on a cents per Mcf basis, are shown on Task Force Table No. B-5 hereto.

Appendix A, Tables 7, 9, and 10 of the Foster study reflect the results of projected field prices assuming deliveries under all contracts. Field prices for all future deliveries to interstate pipelines have been projected by combining price estimates for new supplies (assuming all such supplies will be committed at each market price estimate) and price estimates for supplies

Task Force Table No.B-5

Estimated Revenue Impact of Deregulation

Deregulation of All Sales 1/ (¢/Mcf)	Annual Revenue Impact (million \$)	Deregulation of Terminating Contracts Only 1/ (¢/Mcf)	Annual Revenue Impact (million \$)	Phased Deregulation Of All Existing Sales 1/ (¢/Mcf)	Annual Revenue Impact (million \$)	New Sales Only 2/ (¢/Mcf)	Annual Revenue Impact (million \$)
<u>Assuming 55¢ Market Price and 1¢ Annual Escalation</u>							
1/1/74 26.26	\$ 629.2	22.35	\$ 117.9	23.33	\$ 246.0	22.08	Not Estimated
1/1/75 28.16	745.2	23.37	158.4	25.77	452.2	24.75	Not Estimated
1/1/77 29.87	769.3	25.21	276.4	29.87	769.3	30.11	Not Estimated
1/1/80 34.21	879.1	30.32	560.0	34.21	879.1	39.52	Not Estimated
<u>Assuming 65¢ Market Price and 1¢ Annual Escalation</u>							
1/1/74 27.42	\$ 781.0	22.64	\$ 156.3	23.83	\$ 311.4	22.27	Not Estimated
1/1/75 29.73	937.6	23.79	210.1	26.76	573.6	25.54	Not Estimated
1/1/77 31.70	962.7	26.03	363.4	31.70	962.7	32.23	Not Estimated
1/1/80 36.87	1,097.4	32.31	723.1	36.87	1,097.4	43.80	Not Estimated
<u>Assuming 75¢ Market Price and 1¢ Annual Escalation</u>							
1/1/74 28.58	\$ 932.8	22.94	\$ 194.7	24.35	\$ 379.4	22.46	Not Estimated
1/1/75 31.29	1,128.8	24.22	261.8	27.36	696.1	26.33	Not Estimated
1/1/77 33.53	1,156.1	26.85	449.7	33.53	1,156.1	34.36	Not Estimated
1/1/80 39.53	1,315.7	34.30	886.2	39.53	1,315.7	48.07	Not Estimated

1/ Estimated revenue per Mcf, all existing contracts,

2/ Estimated revenue per Mcf, all contracts.

Note: The above estimates compare with the average field price of 20.48¢ per Mcf for all interstate gas deliveries as of 1/1/73.

Source: Foster Associates, Inc. August 1973 Report for API Appendix A, Tables 1-B, 1-C, 1-D, 3-B, 3-C, 3-D, 4-B, 4-C, 4-D, 6-B, 6-C and 6-D

delivered under existing contracts based on a contract-by-contract analysis using estimated volumes for each type of delivery. 4/ Selected excerpts from Tables 7 and 9 of the Foster Study are shown on Task Force Tables B-6 and B-7 hereto.

4/ Foster states that the amount of new supply which will be found and developed and will provide the reserve inventory out of which "new" gas deliveries will be made cannot be predicted. Delivery volumes for new gas used in the estimates, together with projected old gas volumes, imply that total production would be fairly stable through 1976, increasing thereafter by approximately 2 percent annually.

Task Force Table No. B-6

Estimated Average Field Prices

	<u>Deregulation of All Sales</u> (¢/Mcf)	<u>Deregulation of New Sales and Phased Existing Sales</u> (¢/Mcf)	<u>Deregulation of New Sales and Expired Contracts</u> (¢/Mcf)	<u>Deregulation of New Sales Only</u> (¢/Mcf)
<u>Assuming 55¢ Market Price and 1¢ Annual Escalation</u>				
1/1/74	26.80	23.93	22.96	22.08
1/1/75	30.35	28.15	25.94	24.75
1/1/77	35.84	35.84	32.17	30.11
1/1/80	45.66	45.66	43.43	39.52
<u>Assuming 65¢ Market Price and 1¢ Annual Escalation</u>				
1/1/74	28.12	24.60	23.44	22.27
1/1/75	32.58	29.85	27.12	25.54
1/1/77	39.41	39.91	34.94	32.23
1/1/80	50.45	51.45	48.84	43.80
<u>Assuming 75¢ Market Price and 1¢ Annual Escalation</u>				
1/1/74	29.45	25.30	23.92	22.46
1/1/75	34.81	31.56	28.30	26.33
1/1/77	42.97	42.97	37.71	34.36
1/1/80	57.25	57.25	54.25	48.07

Note: The above estimates compare with the average field price of 20.48¢ per Mcf for all interstate gas deliveries as of 1/1/73.

Source: Foster Associates, Inc. August 1973 Report for API, Appendix A, Tables 7-B, 7-C and 7-D

Task Force Table No. B-7

Estimated Increase From 1/1/73 In
Annual Cost Of Residential Gas Service

	<u>Immediate Deregulation of All Sales</u>	<u>Deregulation of New Sales and Phased Deregulation of Existing Sales</u>	<u>Deregulation of New Sales Only</u>
<u>Total Annual Increase From 1/1/73 Assuming 55¢ Market Price and 1¢ Annual Escalation</u>			
1/1/74	\$ 8.30	\$ 4.53	\$ 2.10
1/1/75	12.96	10.07	5.61
1/1/77	20.17	20.17	12.61
1/1/80	33.06	33.06	25.00
<u>Total Annual Increase From 1/1/73 Assuming 65¢ Market Price and 1¢ Annual Escalation</u>			
1/1/74	\$ 10.03	\$ 5.41	\$ 2.35
1/1/75	15.89	12.30	6.64
1/1/77	24.86	24.86	15.43
1/1/80	40.66	40.66	30.62
<u>Total Annual Increase From 1/1/73 Assuming 75¢ Market Price and 1¢ Annual Escalation</u>			
1/1/74	\$ 11.78	\$ 6.33	\$ 2.60
1/1/75	18.82	14.55	7.68
1/1/77	29.53	29.53	18.22
1/1/80	48.28	48.28	36.23

Source: Foster Associates, Inc. August 1973 Report For API,
Appendix A, Tables 9-B, 9 C and 9-D.

Natural Gas Regulation
An Evaluation of FPC Price Controls
Robert B. Helms

This publication attempts to analyze the effects of regulation on the natural gas industry. After providing background information on the structure, organization and history of the industry, and its regulation, a model is presented and used to predict the manner producers would have been expected to behave in the absence of regulation.

Helms' main conclusion is that field market regulation provides an example of an unsuccessful attempt to improve social welfare through price controls, an effort which has caused the current natural gas shortage. In contrast, deregulation would reduce future energy costs.

In Helms' evaluation of the economics of an unregulated gas market, the basic goal was to study the effects of field market regulation by comparing the response of producers to three important economic forces for the two periods before and after the establishment of price controls. The three forces are (1) the initial price of gas for long term contracts; (2) the price of crude oil; and (3) the price of natural gas liquids.

An econometric model was developed to evaluate the Commission's recent attempts to stimulate additional reserves by allowing increased new-contract gas prices. The following relationships are derived from the model:

- (1) the new contract price for gas is positively correlated with the desired stock of gas reserves.
- (2) since natural gas and natural gas liquids are produced together, an increase in the price of liquids leads to an increase in the price of natural gas reserves which, in turn, leads to increased production.
- (3) an inverse relationship exists between crude oil prices and natural gas discoveries.

The estimated impact of increased new gas prices on reserves, using the model, is shown in Task Force Table No.B-8.

Task Force Table No. B-8
 Estimated Response Of Gas Reserves To New Contract Prices, 1970-80

Year	Reserves When Prices Equal:		Price Increases at 5% from 26¢ in 1972		Price Increases at 10% from 26¢ in 1972		Price Increases at 15% from 26¢ in 1972	
	26¢ ^a	50¢ ^b	Prices ^c	Reserves	Prices ^c	Reserves	Prices ^c	Reserves
1970	276.2	276.2	18.5	276.2	18.5	276.2	18.5	276.2
1971	279.4	279.4	19.7	279.4	19.7	279.4	19.7	279.4
1972	283.7	283.7	20.6	283.7	20.6	283.7	20.6	283.7
1973	287.1	311.2	21.6	289.2	22.6	291.2	23.7	293.3
1974	289.5	331.6	22.7	295.4	24.9	301.4	27.2	307.7
1975	291.3	346.9	23.8	302.2	27.4	314.0	31.3	326.6
1976	292.6	358.2	25.0	309.8	30.1	328.9	36.0	350.3
1977	293.5	366.7	26.3	317.9	33.1	346.2	41.4	378.9
1978	294.1	372.9	27.6	326.5	36.4	365.7	47.6	412.8
1979	294.4	377.5	28.9	335.7	40.1	387.7	54.7	452.6
1980	294.7	380.9	30.7	345.5	44.1	412.2	62.9	499.0

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a26¢ is equal to 20.6¢ in 1957-59 dollars. The 1973 wholesale price index is 154.16

b50¢ is equal to 32¢ in 1957-59 dollars.

c all new contract price (PG*) projections are in constant dollars (1957-59=100). For the period 1969-72, prices are assumed to increase from 19.7¢ to (20.6¢ deflated), figures which approximate the actual increase.

Source: Natural Gas Regulation. An Evaluation of FPC Price Controls. Table 7. R. B. Helms.

The conclusions drawn from Table No. B-8 are:

- (1) If 1972 ceiling prices are held at 26¢, the stock of reserves will increase 7% by 1980.
- (2) If 1973 prices increase to 50¢ and remain constant, the reserves will increase 38% by 1980.
- (3) Reserves would increase at an increasing rate if the price of gas is assumed to increase at a fixed percentage yearly. For example, if the price of gas is assumed to increase annually after 1972 at 5%, 10% and 15%, then the percentage response in the stock of reserves by 1980 would be 25%, 49% and 81%, respectively.

An estimate is also made of the costs of obtaining domestic gas in an unregulated market as compared to importing substitutes. The procedure followed is to (1) compute a price and quantity series assuming no domestic price controls and no imports and (2) compute a price and quantity series assuming domestic price regulation and an import cost of \$1.00/Mcf.

The result of this study, shown on Task Force Table No. B-9 is that the unregulated average field price rises from 27.5¢ in 1972 to 33.7¢ per Mcf in 1980, and the cost of importing LNG to make up for the domestic shortage created by regulation would average \$657 million each year over the seven years, 1974-1980. Helms states that if the structure of the industry has actually changed since the 1950's so that additional domestic gas can only be found at prices higher than the approximately 30¢ shown in the table, then the projections underestimate the true cost of obtaining additional domestic gas.

Task Force Table No.B-9

Estimated Cost of Imported Versus Domestic Gas, 1972-80

Year	Unregulated Domestic Field Market		Regulated Domestic Market with Imported LNG		Cost of Regulation and Imports ^c (millions of 1973 dollars)
	Price (P ₁) ^a	Quantity (Q ₁) ^b	Price (P ₂) ^a	Quantity (Q ₂) ^b	
1972	27.5	26.1	28.0	26.1	\$139.3
1973	28.4	27.4	29.8	27.2	376.1
1974	29.8	28.4	32.6	27.6	784.8
1975	30.3	28.3	33.1	26.3	760.2
1976	31.5	28.8	33.7	26.8	640.4
1977	31.7	28.2	34.2	26.9	691.8
1978	32.7	28.7	34.7	27.2	565.4
1979	32.9	28.1	35.2	27.4	643.2
1980	33.7	28.7	35.5	27.5	512.2

^a(P₁) and (P₂): Average price of domestic field consumption, ¢/Mcf. The average price (P₁) is the ten-year average of new contract prices (PG_{t-g}) to (PG_t) where actual new contract prices are used from 1963-71 and PG* is used from 1972 through 1980.

^b(Q₁) and (Q₂): Trillions of cubic feet. The initial volume of 26.113 Tcf in 1972 is from the FRC projection R₇₁ used in the computations is 247.44 Tcf, the actual level of reserves for the contiguous forty-eight states.

^c Figures may not add due to rounding.

Source: Natural Gas Regulation. An Evaluation of FPC Price Controls. Table 6. R. B. Heims

The Economics of the Natural Gas Shortage (1960-1980)
P. W. MacAvoy and R. S. Pindyck

This report develops a model in an attempt at comparing the effects of policy alternatives available for dealing with the natural gas shortage.

MacAvoy-Pindyck point out that given the large number of alternative proposals under the rubric of "deregulation" of field prices, no single price schedule can be proposed for an exact depiction of market conditions under decontrol. Most proposals, however, would allow new contract prices to seek their own levels after 1980, with increasingly higher ceilings on new contract prices in the intervening period. ^{1/} Ceilings would not eliminate excess demand in the middle 1970's, because they would be set to prevent substantial price increases in the immediate future. Many rules of thumb have been proposed for setting the interim prices, among the most frequently suggested of which is that of keeping average wholesale prices from increasing by more than 100 percent over the 1975-1980 period. ^{2/} Using wellhead prices in keeping with such interim ceilings, a representative sequence would include a 25 cent increase in 1975, with 5¢ per annum increases thereafter. Simulations with this price sequence have been completed as representative of price and production behavior under "phased deregulation."

^{1/} The authors stress that "phased deregulation" is in no way a synonym for complete deregulation within a few months' time. The changes of acceptance of complete and instantaneous deregulation by Congress seemed so small, it was not examined by the authors. Also, the authors state that there is no analytically acceptable procedure for simulating complete deregulation. Extrapolation of relationships during regulation, to indicate other relationships in unregulated markets, seems unacceptable; the changes in patterns of price expectations alone would be so great as to eliminate any similarities of producer performance under the two regimes of control. The authors state that simulations of "phased deregulation" over the next five years seem to be legitimate, since they involve the continued use of price controls of the nature of those in the 1960's and 1970's.

^{2/} The authors state that these price equivalents were presented to members of the House of Representatives in individual briefings in the spring of 1974 by the Columbia Gas System as a basis for legislative proposals allowing higher gas prices.

As shown in Task Force Table No. B-10, the simulations indicate increased discoveries each year, up to 29 Tcf by 1980 and total reserves to the level of 270 Tcf by that time. The impact of the 25¢ price increase on new discoveries will begin to appear in the second and third years. Production out of reserves would increase somewhat faster than reserve accumulations, rising from 23 Tcf in 1972 to 35 Tcf in 1980.

As a result of the pass-through of the higher new contract field prices to the wholesale level, simulated demands for gas are reduced. Demands for gas increase to only 35.1 Tcf by 1980. "Phased" increases in gas prices curtail the growth in demand for production by almost 36 percent.

MacAvoy-Pindyck provide an overview of their econometric model which incorporates the important characteristics of (1) simultaneously describing the behavior of both reserves and production markets, (2) describing the regional organization of the industry on a disaggregated level, and (3) accounting for the time dynamics inherent in the various activities of the industry. Task Force Figure No. B-1 provides a block diagram of basic relationships between the producing and consuming markets.

The important exogenous determinants of demand for gas and oil include state-by-state value added in manufacturing, population, income, and capital equipment additions. MacAvoy-Pindyck assumed that value added, income, and capital additions will grow at 4.2 percent per annum in terms of constant dollars. They chose a conservative expected rate of growth of prices of 6.5 percent; the rate of inflation likely to prevail in the late 1970's is rather uncertain and is under considerable debate, and the rate of 6.5 percent simply represents a rough average of several inflation forecasts that have been made recently. Thus, value added, income and capacity grow at 10.7 percent in current dollar terms. The authors assumed that the rate of growth of population will be limited to 1.1 percent per annum for the rest of the decade (in keeping with the assumptions used in the economy-wide models for generating the rates of growth of value added and capacity). The domestic price of crude oil is assumed to remain constant at \$6.50 per barrel in 1974 dollars for the remainder of the decade, and wholesale prices for both distillate and residual oil are also assumed to remain constant in real terms. Finally, average drilling costs are expected to increase at a rate of 3.3% per annum in real terms, in keeping with the trend of cost increases over the late 1960's and early 1970's.

Task Force Table No. B-10
Econometric Forecast For Phased Deregulation Policy

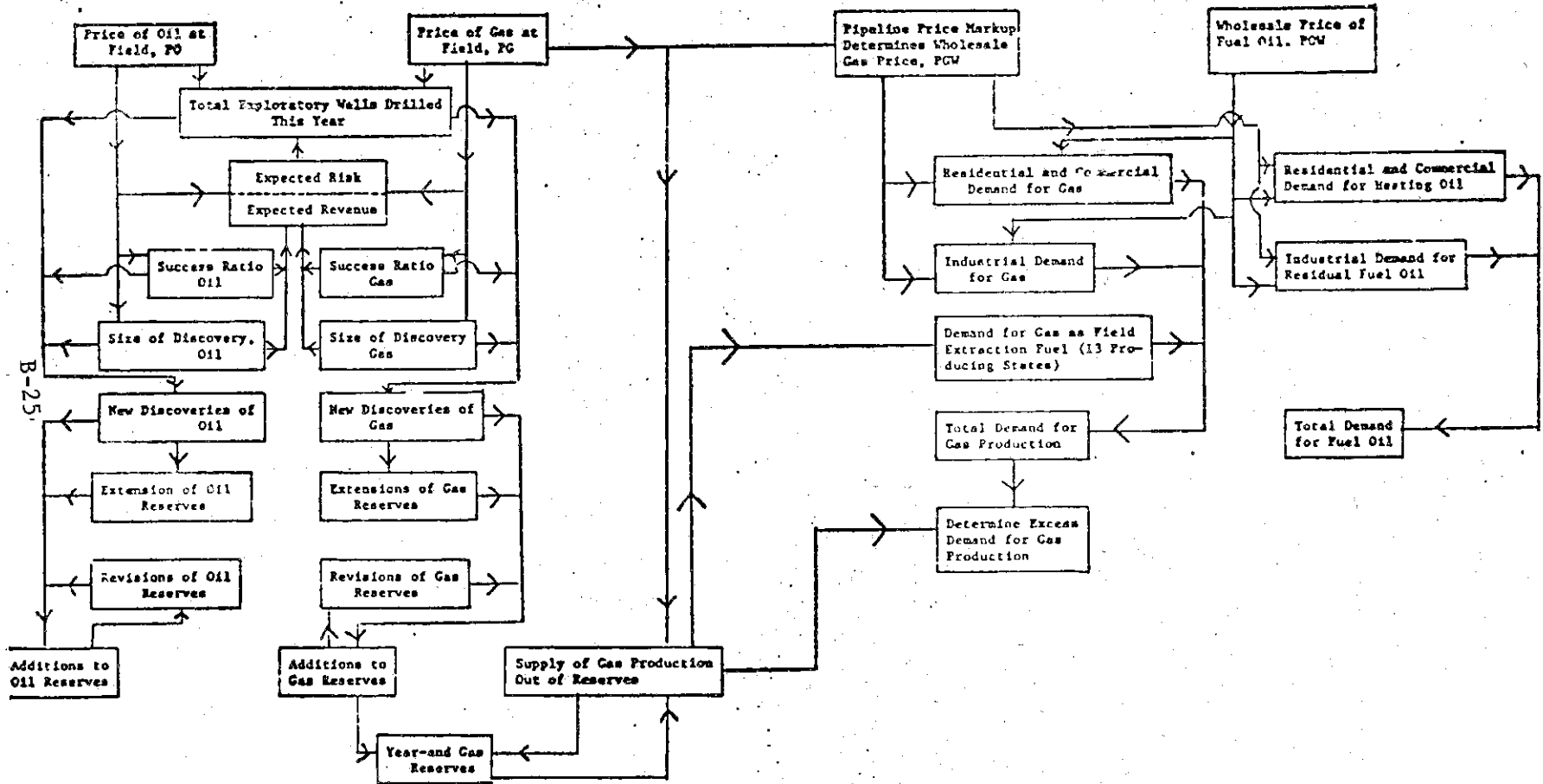
Year	New Discoveries (Continental U.S., trillions of cu.ft.)	Total Additions to Reserves (Continental U.S., trillion of cu.ft.)	Total Reserves (Continental U.S., trillions of cu.ft.)	Supply of Production (Continental U.S., trillions of cu.ft.)	Demands for Production (Continental U.S., trillions of cu.ft.)	Excess Demand for Production (Continental U.S., trillions of cu.ft.)	New Contract Field Price (Continental U.S., cents per Mcf)	Average Wholesale Price (Continental U.S., cents per Mcf)
1972	4.7	8.8	233.4	23.3	23.5	0.1	31.6	39.7
1973	10.1	17.5	228.3	23.7	24.3	0.6	34.6	41.3
1974	10.0	19.0	224.0	24.5	26.3	1.7	39.7	44.3
1975	16.7	25.5	224.1	26.8	28.6	1.8	64.6	52.8
1976	21.6	31.2	228.8	28.1	30.5	2.3	69.7	59.2
1977	25.3	35.8	237.1	29.2	31.9	2.7	74.8	65.3
1978	29.8	41.4	249.5	30.9	33.2	2.2	79.9	71.8
1979	29.8	42.8	261.5	32.9	34.2	1.2	85.1	78.1
1980	28.9	41.8	270.7	35.0	35.1	0.1	90.3	84.1

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Source: The Economics of the Natural Gas Shortage (1960-1980), Table 2.4.
P. W. MacAvoy and R.S. Pindyck

Task Force Figure No. B-1

Block Diagram of the Econometric Model



Source: The Economics of the Natural Gas Shortage (1960-1980).
 Figure 3-1. P. W. MacAvoy and R. S. Pindyck.

MacAvoy-Pindyck note that these values of the exogenous variables can be altered, and new values inserted into the model to produce new simulations that would indicate how the forecast results previously set forth would depend on the particular assumptions that have been made. The authors state that it is of particular interest to determine how these results depend on the assumptions made regarding the price of oil, the future of which is open to considerable speculation, as well as assumptions made regarding general economic conditions such as the growth in output and the rate of inflation. As an alternative to the set of "medium" assumptions for exogenous variables described above, MacAvoy-Pindyck have chosen "high" and "low" assumptions for both oil prices and economic variables.

In contrast to the "medium" scenario for oil prices, the authors offer a "low" scenario in which the crude oil price declines by 25¢ per barrel each year (from \$6.50 in 1974 to \$5.00 in 1980) and a high scenario in which the price of crude oil increases from \$6.50 per barrel in 1974 to \$7.50 per barrel in 1980 (again in constant 1974 dollars). Wholesale oil prices (as well as prices for alternative fuels such as coal and electricity) are assumed to change in these scenarios at the same percentage rate as the crude oil price.

In contrast to the "medium" scenario for economic growth, MacAvoy-Pindyck offer a "low" scenario in which output variables (such as income, value added, and capital additions) grow at 2.5 percent in real terms with a rate of inflation of 4.0 percent, and a high scenario in which output variables grow at 5.0 percent in real terms and the rate of inflation is 8.0 percent. See Task Force Table Nos. B-11 and B-12 for phased deregulation under three oil price scenarios and phased deregulation under three economic scenarios.

MacAvoy-Pindyck conclude that phased deregulation is necessary to lessen the natural gas shortage.

Task Force Table No. B-11
 Forecasts for "Phased Deregulation" Under Three Oil Price Scenarios*
 Assuming Medium Economic Conditions

Year	New Discoveries		Total Additions to Reserves		Total Reserves		Supply of Production		Demand for Production		Excess Demand		New Contract Price		Average Wholesale Price	
	Superscript	Subscript	Superscript	Subscript	Superscript	Subscript	Superscript	Subscript	Superscript	Subscript	Superscript	Subscript	Superscript	Subscript	Superscript	Subscript
1972	4.7	4.7	8.8	8.8	233.5	233.5	23.3	23.3	23.5	23.5	0.2	0.2	31.7	31.7	39.9	39.9
1973	10.2	10.2	17.5	17.5	228.4	228.4	23.7	23.7	24.3	24.3	0.7	0.7	34.7	34.7	41.6	41.6
1974	10.1	10.1	19.0	19.0	224.0	224.0	24.6	24.6	26.4	26.4	1.7	1.7	39.7	39.7	44.7	44.7
1975	16.7	16.6	25.6	25.4	224.2	224.0	26.8	26.8	28.7	28.7	1.9	1.8	64.7	64.7	52.8	52.8
		17.0		25.8		224.4		26.8		28.4		1.6		64.7		52.8
1976	21.6	21.4	31.3	31.1	228.8	228.5	28.2	28.2	30.5	30.6	2.3	2.4	69.7	69.7	59.3	59.3
		22.0		31.6		229.4		28.2		29.6		1.5		69.7		59.3
1977	25.4	25.2	35.8	35.6	237.1	236.6	29.2	29.2	32.0	32.3	2.8	3.0	74.8	74.8	65.4	65.4
		25.8		36.2		238.1		29.2		30.3		1.1		74.8		65.4
1978	29.9	29.7	41.5	41.4	249.6	248.9	31.0	31.0	33.2	33.9	2.3	2.9	80.0	80.0	71.9	71.9
		30.0		41.6		250.6		31.0		30.4		-0.6		80.0		71.9
1979	29.8	29.3	42.8	42.4	261.6	260.5	33.0	32.9	34.3	35.4	1.3	2.5	85.1	85.1	78.2	78.2
		29.8		42.7		262.4		33.0		30.1		-2.9		85.1		78.2
1980	28.9	25.5	41.8	38.4	270.7	266.3	35.0	35.0	35.2	37.1	0.1	2.1	90.3	90.3	84.2	84.2
		29.3		42.0		271.6		35.1		29.4		-5.7		90.3		84.2

*Superscript and subscript denote highest and lowest alternatives respectively.

Note: All quantities in trillions of cubic feet, and prices in cents/Mcf.

Source: The Economics of the Natural Gas Shortage (1960-1980), Table 5. 22, P.W. MacAvoy and R. S. Pindyck.

Task Force Table No. B-12

(Page 1 of 2)

"Phased Deregulation" Forecasts Under Three Economic Scenarios*
Assuming Medium Oil Price Conditions

Year	New Discoveries	Total Additions to Reserves	Total Reserves	Supply of Production	Demand for Production	Excess Demand	New Contract Price	Average Wholesale Price
1972	4.7	8.8	233.5	23.3	23.5	0.2	31.7	39.9
	4.7	8.8	233.5	23.3	23.5	0.2	31.7	39.9
	4.7	8.8	233.5	23.3	23.5	0.2	31.7	39.9
1973	10.2	17.5	228.4	23.7	24.3	0.7	34.7	41.6
	10.2	17.5	228.4	23.7	24.3	0.7	34.7	41.6
	10.2	17.5	228.4	23.7	24.3	0.7	34.7	41.6
1974	10.1	19.0	224.0	24.6	26.4	1.7	39.7	44.7
	10.1	19.0	224.0	24.6	26.4	1.7	39.7	44.7
	10.1	19.0	224.0	24.6	26.4	1.7	39.7	44.7
1975	16.6	25.5	224.1	26.8	28.8	2.0	64.7	52.8
	16.7	25.6	224.2	26.8	28.7	1.9	64.7	52.8
	16.9	25.7	224.3	26.8	28.4	1.6	64.7	52.8
1976	21.5	31.2	228.6	28.2	30.8	2.7	69.7	59.3
	21.6	31.3	228.8	28.2	30.5	2.3	69.7	59.3
	21.8	31.5	229.1	28.2	29.8	1.6	69.7	59.3
1977	25.3	35.7	236.8	29.2	32.6	3.4	74.8	65.4
	25.4	35.8	237.1	29.2	32.0	2.8	74.8	65.6
	25.6	36.0	237.7	29.2	30.7	1.5	74.8	65.4
1978	29.8	41.4	249.2	31.0	34.3	3.4	80.0	71.9
	29.9	41.5	249.6	31.0	33.2	2.3	80.0	71.9
	29.9	41.6	250.1	31.0	31.1	0.1	80.0	71.9

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Task Force Table No. B-12
(Page 2 of 2)

"Phased Deregulation" Forecasts Under Three Economic Scenarios*
Assuming Medium Oil Price Conditions

<u>Year</u>	<u>New Discoveries</u>	<u>Total Additions to Reserves</u>	<u>Total Reserves</u>	<u>Supply of Production</u>	<u>Demand for Production</u>	<u>Excess Demand</u>	<u>New Contract Price</u>	<u>Average Wholesale Price</u>
1979	29.6	42.7	261.0	33.0	35.9	2.9	85.1	78.2
	29.8	42.8	261.6	33.0	34.3	1.3	85.1	78.2
	29.9	42.8	262.0	33.0	31.1	-1.9	85.1	78.2
1980	27.3	40.3	268.7	35.0	37.5	2.5	90.3	84.2
	28.9	41.8	270.7	35.0	35.2	0.1	90.3	84.2
	29.8	42.6	271.9	35.1	30.7	-4.4	90.3	84.2

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* Superscript and subscript denote highest and lowest alternatives respectively.

NOTE: All quantities in trillions of cubic feet, and prices in cents per mcf.

Source: The Economics of the Natural Gas Shortage (1960-1980), Table 5.24, P. W. MacAvoy and R. S. Pindyck.

Joint Costs and Separability
in Oil and Gas Exploration
E. W. Erickson and R. M. Spann

The focus of this study is on the long term supply of oil and natural gas. Using econometric techniques, the authors try to estimate the response of supply to such economic factors as prices, interest rates, and time.

In the Erickson-Spann model, the theory of joint costs is applied to petroleum exploration to derive the long run supply functions of crude oil and natural gas. The model demonstrates that there is no a priori reason to believe that the cross elasticity of supply which is the percentage change in the quantity of oil (gas) discovered due to a unit percentage change in gas (oil) prices, is either negative or positive.

Using their model, Erickson-Spann found that prices need to increase between 60 and 100 percent in order to eliminate the natural gas shortage. If such increased prices had been in effect for the last several years, the effect would have been a significant increase in supply, since gas would be a less attractive fuel at higher prices.

Erickson-Spann estimate a market clearing price in the range between 37¢ - 50¢ per Mcf. Assuming an equilibrium price of 43.5¢ per Mcf, a 10 percent annual increase in demand, a minus 7 percent annual shift in gas supply, an inelastic demand curve for natural gas, a supply elasticity of discoveries of +3.0, and assumed wellhead price increases of 6 percent a year, their model projects equilibrium wellhead prices and non-associated gas discoveries for the period 1972 through 1985. The results are shown in Task Force Table No. B-13. In order for discoveries of new reserves to increase from 13 Tcf in 1972 to 44.9 Tcf in 1985 as shown in the table, Erickson-Spann state that extensive drilling must occur in the offshore area.

The authors conclude that complete deregulation is necessary to eliminate the natural gas shortage. Although this would involve sharp immediate increases in natural gas prices, the authors contend that it would be better to pay this cost now rather than draw out the process of deregulation, continue to extend the shortage into the future, and run the risk of additional, administratively induced resource misallocations.

Task Force Table No. B-13
 Projections of Non-Associated Natural Gas Prices and
 Required Discoveries, 1972-1985.

Year	Real Price * (cents per Mcf)	Nominal Price* (5% a year Inflation)	Required annual discoveries of ultimately recoverable non-associated natural gas (trillion cubic feet)
1972	43.5	43.5	13.0
1973	46.1	48.4	14.3
1974	48.9	53.8	15.7
1975	51.8	59.9	17.3
1976	54.9	66.6	19.0
1977	58.2	74.1	20.9
1978	61.7	82.5	23.0
1979	65.4	91.8	25.3
1980	69.3	102.2	27.8
1981	73.5	113.7	30.6
1982	77.9	126.5	33.7
1983	82.6	140.8	37.1
1984	87.6	156.7	40.8
1985	92.9	157.8	44.9

Source: Joint Costs and Separability in Oil and Gas Exploration. Table 2.
 E. W. Erickson and R. M. Spann.

* Flowing and new gas.

Energy Regulation by the Federal Power Commission
Stephen G. Breyer and Paul W. MacAvoy

In order to analyze the dimensions of the gas shortage, Breyer and MacAvoy built a supply and demand model of the field sales market. The goal of this study was to determine what level of prices would have been required to prevent the gas shortage which developed in the 1960's and which the authors state was caused by the restrictive pricing policies of the Federal Power Commission.

The assumption was made that prices for field sales would have risen during the sixties without regulation, due to slow supply response in alternative energy markets. Data sources for the model included the AGA and the FPC.

Once the parameters for the analysis were established, various data from the 1960's were selected for those variables generating the supply and demand schedules and inserted in the model to estimate market equilibrium conditions for this period. The exogenous variables included producing districts, reserves demanded, capital stock of gas burning furnaces, index of all retail fuel prices, distance, rate of interest and oil prices. A two-stage least squares technique was used to find the supply and demand equations. The next step was to estimate the prices and quantities of gas which would have cleared markets given the estimated parameters and given the exogenous variables for the period 1961-68.

The overall conclusion reached by the authors is that reserves added from 1961-1968 would have been triple the actual number had regulation not been in effect. Production for that period would have been twice the actual, and price per Mcf would have progressed from three to ten cents higher over the period. (See Task Force Table No. B-14)

The authors state that the gas shortage can be attributed to field price regulation, in that the continuation of 1955-60 market processes rather than regulatory ceiling prices would have prevented excess demands for reserves.

Task Force Table No. B-14

Actual Prices and Simulated Unregulated Prices, Production,
and Changes in Reserves of Natural Gas, East Coast and Midwest, 1961-68

Year	Price P_{ij} (cents per Mcf)		Production ΔQ_{ij} (billions cu. ft.)		Changes in reserves ΔR_{ij} (billions cu. ft.)	
	Actual average price	Simulated*	Actual	Simulated*	Actual	Simulated*
1961	17.7	20.0	292	817	5,567	12,480
1962	19.0	21.1	230	755	5,805	12,858
1963	16.5	22.4	447	688	4,884	13,077
1964	16.7	22.9	200	814	5,512	13,221
1965	17.4	24.1	348	750	6,015	13,621
1966	17.2	25.5	347	627	4,204	14,147
1967	17.4	26.7	575	520	3,693	15,026
1968	18.0	27.8	431	548	951	15,572

Sources: American Gas Association (AGA) Reserves of Crude Oil (1969) . pp. 175-219, Tables XVII-1 to XVII-45; AGA, American Petroleum Institute, and Canadian Petroleum Association, Summary of Estimated Annual Discoveries of Natural Gas Reserves, various issues.

* The simulations are estimates of what the values would have been without FPC regulation.

Source: Energy Regulation by the Federal Power Commission, Table 3-3, Breyer and MacAvoy.

The effect of the shortage, as the authors see it, impacted most heavily on the interstate residential customer. The regulated pipelines received less than their share of the new reserves in the late 1960's as compared with earlier years. Also, total production to residential users declined by two percent between 1962 and 1968. The decline was caused by a large increase in unregulated industrial sales. Finally, sales to industrial users by intrastate pipelines and directly by producers expanded more rapidly than sales by interstate pipelines, which themselves were expanding sales to industrial users by 24 percent.

The authors contend that deregulation is required to alleviate excess demand for natural gas and current shortages. They suggest that, through economic analyses, the Commission determine whether or not competitive conditions exist in each producing region and allow new gas prices to approach market clearing levels unless the evidence suggests that the producers possess monopoly power. Using prices for gas in the competitive areas as benchmarks, the Commission would set prices in those few regions where monopoly power existed.

In a workably competitive context, the authors state that the market-set price will ratify the determination of gas sales "at the lowest possible reasonable rate consistent with the maintenance of adequate service in the public interest." Any other price will be either too high, thereby unreasonably taxing consumers, or too low, thus preventing adequate service.

Letter of September 25, 1974, from
David S. Schwartz, Assistant Chief,
Office of Economics, FPC, to
Senator Warren G. Magnuson

Dr. David S. Schwartz's letter was in response to Senator Magnuson's request for an estimate of the impact of "new" gas deregulation on the economy between 1974 and 1980 assuming the enactment of the "Buckley Bill" (S.3040). 1/

Dr. Schwartz estimates the cost would be between \$9.2 to \$11.2 billion for the "immediate" impact of deregulation on the consumer in 1975, while the 1976 - 1980 impact is projected as \$54 to \$58 billion. The following assumptions were used in his calculations.

Immediate Impact (1975)

Assumptions

1. Current (1973) total interstate and intrastate annual natural gas sales (marketed production) of 22.5 Tcf will continue.
2. Of the 22.5 Tcf annual natural gas sales, 11.5 Tcf are subject to FPC jurisdiction (based on 1973 sales).
3. Short-term sales subject to FPC jurisdiction (consisting of limited-term sales and 60 - 180 day sales) will amount to 657 million Mcf (based on deliveries made in 1973).
4. The price paid for short-term sales will increase to \$1.25/Mcf.
5. Volumes sold under interstate contracts that have or will expire by 1975 are 1.6 Tcf.

1/ In essence, the "Buckley Bill" proposes to end Federal regulation of the wellhead rate at which new gas is sold in interstate commerce.

6. The price paid for the 1.6 Tcf expired contract volumes will increase by an additional \$1/Mcf above the weighted average interstate contract price of 19 cents/Mcf.
7. Of the remaining jurisdictional 9.5 Tcf, one-third to one-half will be sold under renegotiated contracts in 1975.
8. The current average price for the remaining jurisdictional 9.5 Tcf is about 25 cents/Mcf.
9. The conceivable price range for renegotiated volumes is between 75 cents and \$1/Mcf rather than 25 cents/Mcf.
10. Deregulation of interstate gas sales by independent producers will put substantial upward pressure on intrastate market gas prices.
11. The price paid for intrastate volumes of 11.0 Tcf will increase by an additional 50 cents/Mcf.

Five-Year Projected Impact (1976-1980)

Assumptions

1. Current (1973) annual natural gas sales (marketed production) of 22.5 Tcf will continue at the same level each year.
2. Of the 22.5 Tcf annual natural gas sales, 11.5 Tcf are subject to FPC jurisdiction (based on 1973 sales).
3. Short-term sales volumes will be 500 Bcf a year for a total of 2.5 Tcf for the 5-year period. 2/
4. The price paid for volumes under short-term contracts will be \$1.25/Mcf. 2/

2/ Memorandum of October 1, 1974, from Assistant Chief, Office of Economics, to Chairman Nassikas.

5. Expired contract volumes of 4.0 Tcf would cost an additional \$10.0 billion, adjusted downward from 15.8 billion to reflect potential depletion of reserves. 2/ 3/
6. Shut-in natural gas reserves of 4.7 Tcf of proved reserves and 3.3 Tcf of probable reserves located under Gulf of Mexico Federal Offshore Leases will be produced and sold during the 5-year period.
7. The price paid for shut-in reserve volumes will range between \$1 and \$1.50/Mcf.
8. The volumes sold under renegotiated contracts during the period will be 14.0 Tcf. 2/ 4/
9. The average price increase for renegotiated volumes will be 75 cents/Mcf.
10. Intrastate volumes sold during the period will total 55.0 Tcf. 2/
11. The average price increase for intrastate volumes will be 50 cents/Mcf. 2/

The elements of the increased cost of deregulation both in 1975 and the five-year period from 1976-1980 are shown in the attached Task Force Table No. B-15.

2/ Supra

3/ Source: Table 6 of Dr. Schwartz's Statement of June 27, 1973, before Antitrust and Monopoly Subcommittee of the Senate Committee on the Judiciary.

4/ The 14.0 Tcf was derived as follows: Interstate annual sales of 11.5 Tcf x 5 years = 57.5 Tcf. From this total was subtracted 3.5 Tcf of the short-term sales, 4.0 Tcf of expired contract sales, and 8.0 Tcf of shut-in reserves leaving a total of 42.0 Tcf. One-third of these sales (14.0 Tcf) were assumed to be under renegotiated contracts.

Task Force Table No. B-15
SUMMARY OF THE IMMEDIATE AND FIVE-YEAR PROJECTED COST OF DEREGULATION
AS CONTAINED IN DR. DAVID S. SCHWARTZ'S LETTER TO SENATOR MAGNUSON
DATED SEPTEMBER 25, 1974

Type of Volume	Immediate Impact (1975)						Five-Year Projected Impact (1976-1980)					
	Low Estimate			High Estimate			Low Estimate			High Estimate		
	Volume (Tcf)	Cost/Mcf (¢/Mcf)	Added Cost (\$ Million)	Volume (Tcf)	Cost/Mcf (¢/Mcf)	Added Cost (\$ Million)	Volume (Tcf)	Cost/Mcf (¢/Mcf)	Added Cost (\$ Billion)	Volume (Tcf)	Cost/Mcf (¢/Mcf)	Added Cost (\$ Billion)
<u>Jurisdictional Production</u>												
Short-Term Sales	.657	80.3 ^{1/}	528	.657	80.3 ^{1/}	528	2.5	100.0	2.5	2.5	100.0	2.5
Expired Contracts	1.600	100.0	1,600	1.600	100.0	1,600	4.0 ^{5/}	108.0 ^{6/}	10.0 ^{7/}	4.0 ^{5/}	108.0 ^{6/}	10.0 ^{7/}
Renegotiated Contracts ^{2/}	3.160 ^{3/}	50.0	1,600	4.800 ^{4/}	75.0	3,600	14.0 ^{8/}	75.0	10.5	14.0 ^{8/}	75.0	10.5
Shut-In Reserves	-	-	-	-	-	-	8.0	58.0 ^{9/}	4.6	8.0	108.0 ^{10/}	8.6
Jurisdictional Volumes Effected	5.417	68.8	3,728	7.057	81.2	5,728	28.5	96.8	27.6	28.5	126.7	31.6
<u>Intrastate Production</u>												
Intrastate Volumes Effected ^{11/}	11.000	50.0	5,500	11.000	50.0	5,500	55.0	50.0	27.5	55.0	50.0	27.5
<u>Total Volumes Effected</u>	<u>16.417</u>	<u>56.2</u>	<u>\$9,228</u>	<u>18.057</u>	<u>62.2</u>	<u>\$11,228</u>	<u>83.5</u>	<u>66.0</u>	<u>\$54.0 ^{12/}</u>	<u>83.5</u>	<u>70.8</u>	<u>\$58.0 ^{13/}</u>

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- Note: Total marketed production is assumed to be 22.5 Tcf/year of which 11.5 Tcf is assumed to be jurisdictional production and 11.0 Tcf intrastate production.
- ^{1/} Derived by subtracting the weighted average price of 44.7 cents/Mcf paid for short-term sales in 1973 from an assumed "new" gas price of \$1.25/Mcf under deregulation.
 - ^{2/} Assumes that either the "Buckley bill" will permit contracts with "deregulation" clauses in them to be renegotiated or that the Commission will allow these contracts to be renegotiated to include new rates of 75 cents to \$1.00/Mcf compared to the present weighted average jurisdictional rate of about 25 cents/Mcf.
 - ^{3/} Derived by taking one-third of 9.5 Tcf. The 9.5 Tcf represents remaining jurisdictional volumes after short-term sales of 657 Bcf and expired contract volumes of 1.6 Tcf are subtracted from assumed jurisdictional production of 11.5 Tcf.
 - ^{4/} Derived by taking one-half of 9.5 Tcf. (See footnote 3.)
 - ^{5/} Adjusted downward from approximately 14.5 Tcf to reflect the potential decline in production from declining reserves under expiring contracts. The 4.0 Tcf represents 1.6 Tcf of expired contract volumes from 1973 through 1975 and approximately 2.4 Tcf from expiring contracts during the period 1976-1980.
 - ^{6/} Derived by dividing \$15.8 billion by 14.5 Tcf. (See footnote 5.) The \$15.8 billion represents the potential impact of expiring contract volumes that would be sold for \$1.50 or \$1.08 more than the assumed regulated "new" gas price of 42 cents/Mcf. Source: Memo to Chairman Nassikas from Dr. Schwartz dated 10-1-74.
 - ^{7/} Adjusted downward from \$15.8 billion to reflect the potential decline in production from declining reserves under expiring contracts.
 - ^{8/} Derived by taking one-third of 42.0 Tcf. The 42.0 Tcf represents the remaining jurisdictional volumes after subtracting 3.5 Tcf of short-term sales, 4.0 Tcf of expired contract volumes, and 8.0 Tcf of shut-in reserve production from jurisdictional volumes of 57.5 Tcf. (See footnote 6 Source.)
 - ^{9/} Derived by subtracting an assumed regulated price of 42 cents/Mcf from an assumed "new" gas price of \$1.00/Mcf under deregulation.
 - ^{10/} Derived by subtracting an assumed regulated price of 42 cents/Mcf from an assumed "new" gas price of \$1.50/Mcf under deregulation.
 - ^{11/} Assumes that all volumes sold in the intrastate market will increase immediately by an average 50 cents/Mcf upon deregulating the interstate natural gas market.
 - ^{12/} Rounded downward from actual total of \$55.1 billion. (See footnote 6 Source.)
 - ^{13/} Rounded downward from actual total of \$59.1 billion. (See footnote 6 Source.)

Project Independence Report
Federal Energy Administration

This report evaluates the nation's energy problems by assessing the "base case" situation through 1985, if current policies prevail, and considers the impacts and implications of a wide range of major energy policy alternatives.

With respect to natural gas, the report concludes that potential increases in natural gas production are limited, but continued regulation could result in significant declines. For example, as shown in Task Force Table No. B-16, under deregulation, non-associated gas production will rise to 21.4 Tcf by 1985 under "Accelerated Development" and to 18.2 Tcf under "Business as Usual". On the other hand, under regulation with prices at 40 cents per Mcf or less, the table shows that non-associated gas production in 1985 will decline to 9.1 Tcf under "Accelerated Development" and to 9.5 Tcf under "Business as Usual."

With respect to total gas production, the report concludes that continued regulation at today's price will reduce production to 15.2 Tcf by 1985 but with deregulation of gas, production will rise to 24.6 Tcf in 1985 with production from Alaska comprising 1.6 Tcf of this total.

Future gas production possibilities were estimated under Business-as-Usual (BAU) and Accelerated Development (AD) scenarios. Important assumptions common to both possibilities were:

- (1) A 10 percent after-tax rate of return on investment.
- (2) A depletion allowance of 22 percent.
- (3) Cash bonuses and rentals on leases are economic rents and therefore excluded as cost items.

Both scenarios assumed either economic regulation of natural gas prices where prices are allowed to rise to clear the market, or deregulation of new gas supplies.

The analyses lead to the following conclusions:

1. Because of the long lead-times required to bring natural gas production on stream, and because of anticipated declining finding rates, non-associated gas production from the lower 48 states should continue to decline until nearly 1980, regardless of price.

Task Force Table No. B-16

Total Non-Associated Natural Gas
Production Possibilities
BAU^{1/}

<u>Price^{2/}</u>	<u>1974</u>	<u>1977</u>	<u>1980</u>	<u>1985</u>
@ 40¢ (or less)	16.522	15.222	13.337	9.483
@ 60¢ (or less)	16.670	15.847	16.028	16.655
@ 80¢ (or less)	16.670	16.073	16.389	18.139
@ \$1.00 (or less)	16.670	16.075	16.394	18.152
@ \$2.00 (or more)	16.670	16.075	16.400	18.172

AD^{1/}

<u>Price</u>	<u>1974</u>	<u>1977</u>	<u>1980</u>	<u>1985</u>
@ \$0.40 (or less)	16.552	15.284	13.652	9.100
@ \$0.60 (or less)	16.670	16.029	17.781	19.260
@ \$0.80 (or less)	16.670	16.265	18.096	21.344
@ \$1.00 (or less)	16.670	16.267	18.103	21.348
@ \$2.00 (or more)	16.670	16.267	18.110	21.371

^{1/} Production projections are given for the lower 48 states, Alaska and for the natural gas from tight reservoirs.

Production is given in trillion of cubic feet.

AD = Accelerated Development

^{2/} Prices are given in cents per MCF, (in constant 1973 dollars)

Source: Federal Energy Administration, Project Independence Report, Table II-12

2. At a minimum acceptable price of \$1.00 per Mcf under BAU conditions, non-associated marketed production could increase from 16.7 Tcf per year in 1974 to 18.1 Tcf per year in 1985. The major sources of new gas would be in the offshore and onshore Gulf Coast region.

3. Under AD conditions, at a minimum acceptable price of \$1.00 per Mcf, marketed production could reach 21.3 Tcf per year in 1985. Among the sources of further increases in non-associated gas production over the BAU case would be the Atlantic and California OCS.

4. Associated-dissolved gas production levels from the lower 48 states and southern Alaska OCS would depend significantly on oil prices. The 1974 production levels of 3.7 Tcf per year would be reduced in 1977 at prices of \$7 or less per barrel under both BAU and AD assumptions, but would increase in 1985. At \$11 per barrel oil prices, associated-dissolved gas production would increase substantially over \$7 levels.

5. Non-associated gas from both Alaskan regions and associated-dissolved gas from the North Slope could provide major quantities of new gas production. In 1974, this production amounts to only 0.1 Tcf per year. At oil prices of more than \$7 per barrel, production under BAU conditions could reach 1.9 Tcf per year in 1985, while production under AD conditions, with the development of NPR-4 and additional OCS leasing, could reach 3.6 Tcf per year by 1985. The inclusion of transportation costs to the lower 48 states' markets would significantly affect prices.

6. Under the AD scenario, production of gas from tight formations would depend on successful development of recovery technology, but, if successful it could provide as much as 2.0 Tcf per year in added gas production by 1985. The amount of gas recoverable from coal seams is forecast to be negligible.

7. If natural gas prices remain regulated at current levels, the outlook for increased gas supplies is not promising. At the current field price, wellhead production in 1985 could decline by over 6 Tcf per year from 1974 levels (a decline of almost 30 percent). The share of natural gas in interstate markets would also be drastically reduced. The effects of price regulation predominantly impact non-associated gas.

Natural Gas Policy Issues and Options
Staff, National Fuels and Energy Policy Study

Senate Resolution 45, agreed to in May 1971, authorizes the Senate Interior and Insular Affairs Committee to make a full and complete investigation and study of national fuels and energy policies. In 1973, the staff of the National Fuels and Energy Policy Study issued an analysis of natural gas policy issues describing the natural gas industry and the present system of regulation, and identifying the factors contributing to the natural gas shortage. The staff analysis also discusses several changes which could be made to the present system of producer regulation and the impact of each change. Some of the possible changes are as follows:

1. Selective Regulation

This option consists of: (1) FPC regulation of prices which pipeline companies charge their customers for a three year period due to the present supply/demand imbalance to assure that natural gas prices will not exceed competitive market levels; (2) regulation of pipeline and distributor producing affiliates to assure that prices paid by and to such companies are not higher than prices charged for similar sales; and (3) regulation of direct sales by pipelines, and LNG and SNG: Under this option, renegotiation of prices in old contracts would be prohibited for the duration of the primary term of the contract.

The results of selective regulation would be:

1. Relatively slow price increases at the residential level due to the 3-5 year lead time involved in finding and developing new gas. (Homeowners' prices are the result of averaging at several levels from the field to the burner-tip).
2. A more equitable sharing of the nation's natural gas resources between interstate and intrastate consumers due to more reliance on the competitive market for pricing new gas.
3. In terms of long-run equilibrium prices, as supply increases, domestic gas supply would probably be priced lower than imported gas and lower than SNG.

4. Improved expectations of income from the sale of new gas would encourage oil exploration and development.
5. The resource misallocation and inefficient use of natural gas associated with the result of area pricing and the multiprice system would gradually disappear.

The staff analysis also suggests that additional stipulations could be included in selective regulation to assure that the consumer is protected from whatever collusive tendencies may exist in the petroleum industry while providing incentives to increase natural gas supplies.

2. Competitive Market Regulation

This alternative is based on the economic principle that as long as prices are set below competitive market equilibrium levels, a natural gas shortage will exist. Under this option, (1) the FPC would determine the equilibrium price which would be set by a competitive market, (2) small producers (those with annual sales under 10,000,000 Mcf) would be exempted but FPC jurisdiction would be extended to direct sales by pipelines in interstate markets, to gas produced from Federal lands and to SNG and LNG, and (3) prices would be termed "just and reasonable" if they reflect market values and balance of supply and demand (cost of service would not be the preferred standard but could be considered with other evidence).

Under this procedure, the FPC or any State, municipality, State Commission, Federal agency or gas distributing company could intervene within 30 days after the filing of a producer price. The intervenor would be required to show that the seller is an affiliated party, the price is a result of collusion, or the price departs substantially from the price which would have resulted from an arms-length transaction under competitive conditions. Within the next month, the FPC would determine if the case is sufficient to prove that the price is improper. If so, the case becomes jurisdictional and the FPC then has 4 months to determine the correctness of price. The FPC could not suspend the price pending a determination, require refunds of prices paid in the interim or reopen the case once a determination has been made. This option makes no distinction between old and new gas.

Under this option all prices would be reviewed for non-competitive market pricing. Competitive prices would be set in the field in accordance with any special circumstances

involved in the sale. In addition, having competitive market principles as the basis for pricing would be advantageous to increased supply and reduced demand.

The staff study states that disadvantages under this option are that true competitive market price levels are unknown and allowing producers to raise prices for gas sold under old contracts does not necessarily stimulate supply.

3. Deregulation of Producer Prices for All Gas

This option would permit buyers and sellers to set wellhead prices for new gas and to renegotiate prices for gas already under contract ("old" gas). The only control the FPC would still retain is its jurisdiction over pipeline rates; thus, the FPC could prohibit the inclusion of a portion of the price paid to the producer on the grounds that the additional amount represented an "unreasonable cost."

The staff analysis states that even if wellhead prices for new gas reached 65¢ per Mcf, the average field price would increase only gradually to 51.45¢ per Mcf by 1980 according to a study conducted for API by Foster Associates. Under this assumption, consumer prices would rise 6.4% the first year, 3.8% the second year, 3.0%, 2.8% and 3.7% in the succeeding years. Based upon a 55¢ field market price, the initial effect would be a yearly increased gas bill of \$8.30; the total projected increase by 1980 would be \$33.06.

4. Partial and Controlled Trial Deregulation of New Gas

Under this option, new gas could be defined as gas from new wells or gas dedicated to the interstate market only as contracts expire of their own accord. Producers with pipeline or distributor affiliates would be regulated to assure that prices paid to such producers do not exceed (1) the least costly alternative to that affiliated producer or (2) competitive prices charged for similar quantities of gas in the same producing region. For a five year period, the FPC could set ceiling prices by rulemaking proceedings if the ceilings are deemed necessary based on several factors. At the end of each year, the FPC would report on price, supply and demand for all forms of natural gas, and at the end of five years, if the trial was successful both in terms of supply and price, natural gas prices for "new" gas would be deregulated, absent any Congressional intervention.

This system would not result in higher prices for the consumer until "new" gas is delivered to the pipeline. Since the FPC can impose ceiling prices, consumers would be protected from extraordinary price increases due to shortage conditions.

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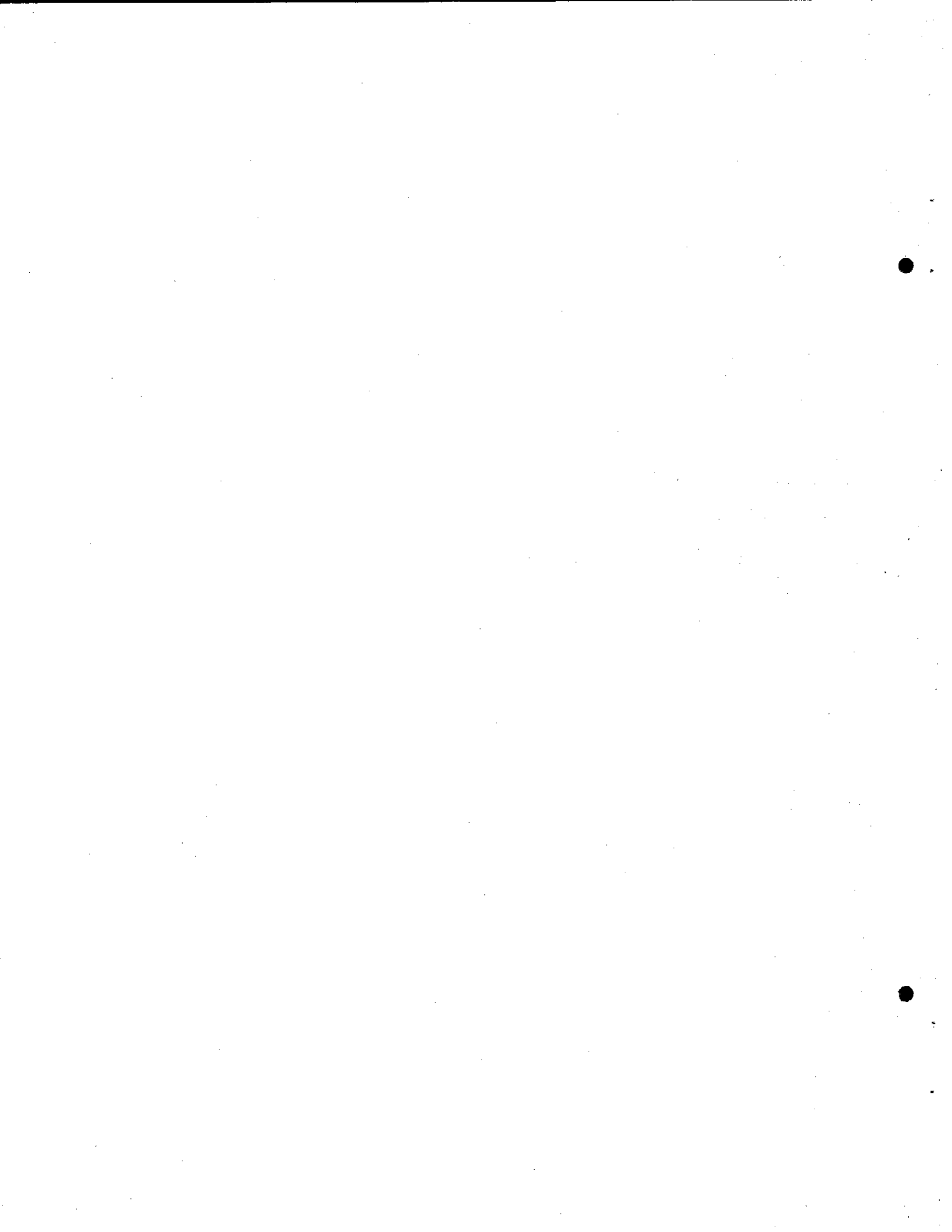
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APPENDIX C

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Discusses activities of Howard T. Boyd, Chairman of El Paso Natural Gas Co. He has been urging Washington to approve a number of ventures designed to improve the supply of natural gas and the corporate health of El Paso Gas. Also El Paso is still trying to over turn a Supreme Court decision ordering the company to surrender Pacific Northwest Pipeline Corp.

Corrigan, Richard.

Questions about energy supply complicate FPC's decision on gas rates. National Journal, v. 3, May 29, 1971: 1144-1150.

"The petroleum industry stands to gain hundreds of millions of dollars a year if the Federal Power Commission agrees to the new gas rates proposed by the natural gas producers. Complicating the FPC's decision is the potential impact on the nation's energy supply."

Corrigan, Richard.

Rising demand for natural gas leads to proposals for high-cost fuel imports. National journal, v. 4, Feb. 2, 1972: 220-226.

Cowan, Edward.

Soviet gas deal held up as U.S. studies cost. New York times, Jan. 9, 1973, p. 49, 54.

Last Nov. 4, three American companies announced they expected to complete a \$3.7-billion investment agreement for the sale of Soviet natural gas to the U.S. The "North Star" venture would be the largest single Soviet-American trade deal so far. Gives details on the proposed project.

Critical time for LNG is next 20 years. Oil & gas journal, v. 70, Oct. 2, 1972: 34-36.

"Technology is proven, and vast investments in transmission and distribution networks around world can be used now only for natural gas. In 1990's nuclear, other energy sources are seen moving to the front."

Culbertson, LeRoy.

Alternate gas supplies are expensive. Oil & gas journal, v. 70, Dec. 25, 1972: 69-72.

U.S. demand for natural gas can no longer be met solely from domestic natural gas production. Summarizes the possible nondomestic energy-source materials and the potential supply-source locations outside the contiguous 48 states.

Dakin, Melvin G.

Rate-making as rule-making--the new approach at the FPC: ad hoc rule-making in the rate-making process. Duke law journal, v. 1973, Apr. 1973: 41-88.

"The primary concern of this article is with FPC's transition from the employment of the full adjudicatory procedure, at one time deemed to be dictated by NGA [section] 5, to the procedures authorized by the APA in classifying rate-making and initial licensing as rule-making."

Davidson, Jeff.

Natural gas and the Federal Power Commission. Indiana law journal, v. 47, summer 1972: 725-741.

Comment examines the natural gas industry, its regulation and the environmental effects of that regulation. Explains briefly the basic legal and administrative structure controlling the industry and focuses particularly on government regulation of the prices and its effect on the supply of natural gas.

Davis, N. Knowles.

A case for rolled-in pricing. Public utilities fortnightly, v. 91, May 24, 1973: 21-26.

The importance of administering regulation in a manner calculated to best serve the public interest is explained. An unreasonably low price level encourages wasteful use of irreplaceable natural resources. This is especially true of natural gas.

Deqasification of coalbeds--a commercial source of pipeline gas. AGA [American Gas Association] monthly, v. 56, Jan. 1974: 4-6.

"An intensive research study conducted by the Department of Interior's Bureau of Mines on degasification of coalbeds for improved mine safety has indicated that commercial quantities of pipeline quality natural gas can be produced."

DeGolyer and MacNaughton.

Twentieth century petroleum statistics, 1974. Dallas, 1974. 120 p.

DiBona, Charles J.

Administration policies affecting the natural gas industry. Public utilities fortnightly, v. 92, Sept. 13, 1973: 78-83.

Diener, William P.

Area price regulation in the natural gas industry of southern Louisiana. Tulane law review, v. 46, Apr. 1972: 695-723.

Considers the producing segment of the natural gas industry in southern Louisiana and the area price regulations applicable to that segment. Main emphasis is placed on concentration, but other elements of market structure, such as product differentiation, price elasticity of market demand, and the ratio of fixed to variable costs in the short run, are discussed.

Diener, William P.

Producer rate regulation--rulemaking at the Federal Power Commission. Natural resources lawyer, v. 5, summer 1972: 378-388.

Article examines "the rulemaking authority of the FPC to set producer area rates, in terms of the statutory requirements of the Administrative Procedure Act (APA) and the Natural Gas Act, as well as applicable judicial interpretations of regulatory agencies' rulemaking authority." Notes the impact of the recent City of Chicago decision on the rulemaking procedures of the FPC.

Doughty, S. Clifford.

Arctic is cold, but solution to energy crisis may be in its waters. *Offshore*, v. 34, May 1974: 181-182, 184, 186, 188, 190, 192, 194.

Discusses the physical problems of drilling for oil and gas in the Arctic (principally Alaska), and the concurrent problems of transportation of those fuels by pipeline and by ship out of the Arctic.

Duane, John W. Karnitz, Michael A.

Domestic gas resources and future production rates. *Power engineering*, v. 79, Jan. 1975: 36-39.

"As natural gas shortages become increasingly severe, speculation grows about maximum reserves and incentives needed to make them available."

Dungan, Malcolm T.

Jurisdiction of the Federal Power Commission over importation of liquefied natural gas. *Natural resources lawyer*, v. 4, Apr. 1971: 276-290.

Argues that the FPC does not have jurisdiction over the importation of liquefied natural gas by tankship.

Duscha, Julius.

Oil: the data shortage. *Progressive*, v. 38, Feb. 1974: 23-25.

"The basic figures on supply of oil and gas remain the best kept secrets of the energy crisis."

Dutkiewicz, Broniek.

Methanol competitive with LNG on long haul. *Oil and gas journal*, v. 71, Apr. 30, 1973: 166-167, 172, 177-178.

"North African or Nigerian gas would probably be more economically imported into the U.S. as LNG. Persian Gulf gas, however, would be more attractive if converted into methanol fuel."

Emery, K. O.

Provinces of promise. *Oceans*, v. 17, summer 1974: 15-19.
Speculates on the magnitude and location of oil and gas reserves in offshore locations worldwide.

Energy. *Environment action bulletin*, v. 4, June 23, 1973: 1-11.

Partial contents.--There is a real energy crisis.--Should we nationalize energy.--Liquefied natural gas: cleaner than most, but is it safe?

Energy and America's future. Panhandle magazine, v. 7, winter 1972-73: 3-50.

Partial contents.--America's energy economy, by Ralph E. Lapp.--Natural gas regulations--new directions, by K. C. Brown.--Synthetics--a new energy frontier, by J. J. McKetta and T. F. Edgar.--Nuclear energy: can it keep its promise?

Energy and development: a case study. Cambridge, Massachusetts Institute of Technology [c1973] 300 p. (Massachusetts Institute of Technology. Sea Grant Project Office. Report no. MITSG 72-16)

Reports on two projects in the Persian Gulf, one involving the establishment of an agro-industrial complex based on natural gas, and the other a dam designed to produce power and yield minerals from evaporated brine.

Energy and man. Dimensions/NBS, v. 57, Aug. 1973: 180-193. This issue is devoted to describing the role of the National Bureau of Standards in solving today's energy problems.

Energy conservation through more effective utilization. Pipeline & gas journal, v. 200, July 15, 1973: 5-9.

Staffs of Energy Communications Inc. publications at a roundtable on the present energy situation agreed that oil and natural gas conservation was part of the solution to shortages.

Discusses fuel conservation methods in industry operations and in consumer areas.

The Energy crisis: time for action. Time, v. 101, May 7, 1973: 41-42, 47-49.

Reports on a three-day energy conference sponsored by TIME in April and held in Nassau, the Bahamas. Various aspects of U.S. energy problems were discussed.

Energy in perspective. Pipeline & gas journal, v. 200, Oct. 1973: 29-36, 70, 76.

Contents.--"A funny thing happened on the way to the energy crisis," by H. G. Harper.--New directions for a responsible industry, by G. J. Doyle.--Block rates--declining v. increasing charges, by Daniel Parson.

Energy Research, inc.

Analysis of salient issues regarding the estimation of proved oil and gas reserve figures. Washington, 1973. 80 p.

Europe's scramble for gas. Petroleum press service, v. 40, Feb. 1973: 53-56.

"New long-term contracts have recently been concluded, or are under consideration, for the delivery to European consumer countries of natural gas from the North Sea, Algeria and the USSR."

Exploration for an exploitation of crude oil and natural gas in the OECD European area. OECD observer, no. 61, Dec. 1972: 10-12.

The administrative, legal and fiscal measures applied in OECD to the exploration for oil and natural gas have much in common. This is brought out in a new report approved by the OECD Oil Committee. Article discusses the situation as it is today.

Falck, Edward.

The natural gas auto and clean air. Public utilities fortnightly, v. 86, July 2, 1970: 38-42.

Faridany, Edward.

LNG: 1974-1990: marine operations and market prospects for liquefied natural gas. London, Economist Intelligence Unit, 1974. 83 p. (Economist Intelligence Unit, ltd., London. QER special no. 17)

Special report deals with growth in the world trade in liquefied natural gas, the requirements for carriers, the cost of carrier operations and some aspects of the problem of financing LNG projects.

Faridany, Edward.

LNG: marine operations and market prospects for liquefied natural gas, 1972-1990. London, Economist Intelligence Unit Limited, 1972. 74 p. (Economist Intelligence Unit, ltd., London. QER special no. 12)

Partial contents.--World trade in liquefied natural gas.--LNG carriers-requirements and availability.--LNG carriers-the cost of operations.--Projects-the question of finance.--The total LNG system.

Fay, James A. MacKenzie, James J.

Cold cargo. Environment, v. 14, Nov. 1972: 21-22, 27-29.

"...reviews the properties of natural gas affecting its transportability, some of the historical developments leading up to the presently planned importation program, and some of the safety hazards posed by the transportation of large amounts of liquid natural gas (LNG) to major U.S. metropolitan ports."

Feldman, Robert Paul.

Ratemaking by informal rulemaking under the Natural Gas Act. Columbia law review, v. 74, May 1974: 752-776.

"This comment will critically analyze the Phillips and Mobil decisions to determine whether ratemaking by informal rulemaking is permissible under the NGA. Then, the propriety of the Mobil court's requirement of hybrid procedures based on its reading of the statutory 'substantial evidence' standard of review will be discussed."

Finneran, James A.

SNG--where will it come from, and how much will it cost? Oil and gas journal, v. 70, July 17, 1972: 83-88.

"Perhaps 10 or 12 plants will be built in the U.S. to gasify naphtha; after that, a jump will be made directly to gasification of whole crude. Third-generation coal-gasification processes still require developmental work, but promise SNG costing less than \$1/1,000 BTU."

Fleming, R. D., and others.

Propane as an engine fuel for clean air requirements. Journal of the Air Pollution Control Association, v. 22, June 1972: 451-458.

"The objective of the study was both to evaluate propane as a low-pollution fuel and to provide information on adjustment of engine parameters for advantageous use of propane as a low-pollution fuel."

Forecast/review: uncertainties plague '75 outlook for oil. Oil and gas journal, v. 73, Jan. 27, 1975: 103-118.

Partial contents.--Forecast of supply and demand.--U.S. production of crude oil and lease condensate.--Marketed production of natural gas.--Crude, product imports.--U.S. reserves.

The FPC has jurisdiction under the Natural Gas Act to regulate the curtailment of natural gas deliveries to direct sale consumers--FPC v. Louisiana Power & Light Co., 406 U.S. 621 (1972). Georgetown law journal, v. 61, Feb. 1973: 833-843.

"From the language of section 1(b) of the Natural Gas Act, it is clear that the FPC has complete authority over sales of natural gas by interstate pipelines to resale customers. Whether the language of the Act allows it to exercise jurisdiction over direct sales to users, however, was the central question in Louisiana Power & Light Co." A case note.

Fradkin, Philip.

Energy search: atomic drilling plan spreads shock waves. Los Angeles times, Feb. 4, 1973, p. 1-B.

Discusses AEC's Project Wagon Wheel, scheduled for 1975 in which five nuclear devices would be placed in well and fired in quick succession to release gas.

The Free market and the energy crisis: MacAvoy, Proxmire, Buckley and Friedman. Business and society review/innovation, no. 9, spring 1974: 82-88.

Excerpts from a seminar on short- and long-term solutions to the energy crisis held in January 1974 by the Schuchman Foundation Center for the Public Interest. Professor Paul MacAvoy discusses the manner in which price controls have inhibited the production of natural gas. Senator William Proxmire and Senator James Buckley debate on the proper role, or non-role, of the Federal Government in providing for adequate supplies of energy. Professor Milton Friedman defends the concept of excess profits made by energy firms.

The Fuel situation--panel discussion. EEI [Edison Electric Institute] bulletin, v. 40, July-Aug. 1972: 178-193.

"The panelists here present their views on the availability of coal, gas, oil, and uranium, on price trends of the various fuels in relation to electricity production, and on a national energy policy."

Contents.--Coal, by Carl E. Bagge.--Gas, by Ralph T. McElvenny.--Oil, by Otto N. Miller.--Uranium, by Dean A. McGee.

Future natural gas requirements of the United States. Volume 3. Prepared by the Future Requirements Committee under the auspices of the Gas Industry Committee. Denver, Future Requirements Agency, Denver Research Institute, University of Denver, 1969. 59 p.

"The Future Requirements Committee submits the results of a national survey of natural gas requirements in the United States on a biennial basis. This is the Committee's third report. The first was issued in December 1964. The second was published in June 1967."

Gardner, Frank J.

Russian LNG coming to U.S.? Probably. Oil & gas journal, v. 70, May 29, 1972: 12-15.

"The Soviets are eager to sell, and the U.S. is eager to buy. Such a project has some big political hurdles to clear, and it could still come a cropper. But most-powerful administration voices favor it."

Gardner, Frank J.

Soviets chortle over gas riches, U.S. supply pinch. Oil and gas journal, v. 68, Sept. 7, 1970: 51-55.

Of 24 "virtually untapped" gas fields "...Soviet reports assert that proved reserves alone for the 24 fields come to more than 290 trillion cu ft. That's nearly 68% of Russia's total estimated proved gas reserves of 426.8 trillion cu ft at the beginning of 1970, and it's 15 trillion cu ft more than overall U.S. proved reserves as of that date."

Gardner, Stephen L.

The energy crisis--outlook for petroleum in the Southwest mixed. Federal Reserve Bank of Dallas business review, Feb. 1974: 1-7.

Gardner, Stephen L.

Natural gas--higher prices might help slow the growing shortage. Federal Reserve Bank of Dallas business review, Mar. 1973: 1-8.

Contents.--Matter of incentives.--Cost-price squeeze.--Regulatory changes.--Need for risk capital.--New approaches.

Gardner, Stephen L.

Natural gas--its impending shortage and potential abundance. Federal Reserve Bank of Dallas business review, Jan. 1971: 1-5.

Contents.--The supply problem.--Growth in demand.--Incentive and prices.--Impact on consumers.--Alternative sources.

Gas/energy. Professional engineer, v. 42, Feb. 1972: 35-42.

Contents.--Natural gas: engineering challenges of the 1970's.--Computers for gas load factor control.--FPC surveying natural gas reserves.--Natural gas situation.--Synthetic pipeline gas from petroleum and coal.

The Gas industry in Algeria. Gas, v. 49, Oct. 1973: 48, 50-52.

"Algeria, one of the countries best situated as to natural gas, and the rapid expansion of the industry, are outlined."

The Gas industry in west Siberia. Current digest of the Soviet press, v. 25, Apr. 18, 1973: 1-4, 16.

"The reserves of gas that have been discovered here are already over 12,000,000,000,000 cubic meters. Predicted reserves are significantly in excess of this gigantic figure."

Gas pipelines: rich get richer, poor get poorer. Commercial and financial chronicle, v. 219, Sept. 23, 1974: 1, 4, 70-71.

Analyzes the financial and supply situation of the natural gas utilities. Says the bottleneck in natural gas production is reinforced by the bottleneck in capital spending cash availability. Notes that the type of shortage facing the natural gas utility is the availability of natural gas at the wellhead.

Gas Utility Advisory Committee.

Conservation of natural gas; a position paper prepared for the Federal Energy Administration. [Washington?] 1974. 41, 25 1.

Some of the conservation programs used by the American Gas Association and individual companies are highlighted in this report.

Gauthier, C. J.

Taking a firm stance. American Gas Association monthly, v. 57, Mar. 1975: 15-17.

"A status report on the natural gas industry."

Gillette, Robert.

Oil and gas resources: did USGS gush too high? Science, v. 185, July 12, 1974: 127-130.

"If the U.S. Geological Survey is right, the United States is at least a decade away from seriously depleting its domestic oil and gas resources. But if several distinguished disbelievers of the Geological Survey are right, the United States is running out of oil and gas right now."

Gilliam, Carroll L.

The Permian Basin Area Rate Cases: new landfalls in rate regulation. Natural resources lawyer, v. 2, July 1969: 193-199.

"...to consider the decision as it actually proceeds from past precedent to what are the practitioner's landfalls for the future, specifically for the fixing of rates and generally for the scope of judicial involvement in a federal natural resources policy."

Gonzales, Ronald R.

Curtailement: increased FPC regulation of direct sales of natural gas. Louisiana law review, v. 33, winter 1973: 335-339.

In Federal Power Commission v. Louisiana Power & Light Co., 92 S. Ct. 1827 (1972), the Supreme Court "held that the FPC has power to authorize curtailment schedules for both resale and direct sales of natural gas under the 'transportation' basis of jurisdiction granted by Congress; and that this section of the act only prohibits FPC regulation of rates of direct sales."

A comment.

Gonzalez, Richard J.

[Oil and gas supplies]: American Petroleum Institute, statement of Dr. Richard J. Gonzalez, consulting economist. In Remarks of Henry Bellmon. Congressional record [daily ed.] v. 118, Aug. 10, 1972: S13224-S13228.

Contents.--Need for more oil and gas.--Record of expansion in production.--Deterioration of U.S. petroleum position.--Observations about relative cost of U.S. and foreign oil and gas.--Large potential for expanding U.S. oil and gas supplies.--Factors which will govern the rate of oil and gas development.--Ways of increasing U.S. oil and gas supplies.--Response of new reserves to changes in exploration.--Influence of existing tax differentials on oil and gas supplies and prices.--National benefits from more rapid development of oil and gas.

Griswold, Gordon C.

Why should distribution companies explore? Public utilities fortnightly, v. 91, Jan. 4, 1973: 17-20.

"The natural gas supply shortage requires distributors to obtain somehow the necessary capital to continue exploration for production."

Guido, Kenneth J., Jr.

The right of the House Judiciary Committee to all presidential documents it deems necessary for its impeachment inquiry. Washington, Common Cause, 1974. 34 p.

Concludes "that no privilege may be constitutionally asserted in an impeachment inquiry; that even if it were permissible to do so, no privilege would sanction the refusal to produce any document requested by the House Judiciary Committee; and that the confidentiality of those matters which should not be made public can be maintained by an in camera inspection by the Judiciary Committee."

Hamilton, Richard E.

Canada's "exportable surplus" natural gas policy: a theoretical analysis. Land economics, v. 49, Aug. 1973: 251-259.

Presents "a model of a natural gas industry, and then uses it to examine the effects on production, consumption and prices of an 'exportable surplus' policy of the type now being used by Canada. Comparisons are made with a policy of free exports and an export tax."

Hansen, Clifford P.

The national energy crisis. In Remarks of Henry Bellmon. Congressional record [daily ed.] v. 118, Sept. 25, 1972: S15774-S15775.

Advocates the construction of the Alaska pipeline, the lifting of controls on the wellhead price of natural gas, and the intensification of offshore and onshore drilling.

Hardt, John P.

West Siberia: the quest for energy. Problems of communism, v. 22, May-June 1973: 25-36.

The author, a Senior Specialist in Soviet Economics in the Congressional Research Service, examines the vast West Siberian regional venture, one of the major capital investment efforts of the Soviet's Ninth Five-Year Plan. Considers the options and constraints facing the U.S.S.R. and the prospects for attainment of Soviet oil and natural gas targets in West Siberia's rich Tyumen Province.

Hardy, Edwin F.

The emergence of U.S. gas utilities as a factor in world petroleum economics. American Gas Association monthly, v. 56, May 1974: 7-11.

Establishes the major factors which are increasing gas companies' role in world petroleum economics.

Hardy, Edwin F.

TERA projections: future natural gas supply reactions to higher prices. American Gas Association monthly, v. 57, Jan. 1975: 6-9.

A.G.A. designed the Total Energy Resource Analysis (TERA), a computerized simulation model of energy supply, demand and prices, with special emphasis on the gas industry. Some results are presented.

Harper, Henry G.

A funny thing happened to me on the way to the gas shortage. Public utilities fortnightly, v. 92, Oct. 25, 1973: 24-27.

"The age of consumerism in which we are now operating demands that we become more--not less--people-oriented. The success and survival of a utility today require a far more sophisticated bag of tools than in the early 'hardware' years of the gas industry's development."

Hart, Philip A.

Dangers in deregulating natural gas. Washington post, Oct. 5, 1974, p. A18.

"But one thing we cannot do--absent a competitive market--is lift price regulation and expect natural gas to flow in sufficient quantities to meet demand."

Hartig, Robert L. Norman, John K.

Production, conservation, and utilization of natural gas in Alaska. Natural resources lawyer, v. 3, Nov. 1970: 694-701.

"In 1955 Alaska enacted comprehensive legislation providing for conservation of the state's oil and gas resources. The Alaska statutes do not specifically provide for market proration; however, the act does prohibit waste."

Heiney, J. W.

Developments in synthetic natural gas. Public utilities fortnightly, v. 95, Feb. 13, 1975: 15-18.

"So, to define the boundaries, this article will review developments--currently and in the foreseeable future--on providing substitute gas supplies which, regardless of variances in energy quality, can help us meet growing requirements."

Helms, Robert B.

Natural gas regulation: an evaluation of FPC price controls. Washington, American Enterprise Institute for Public Policy Research [1974] 83 p. (American Enterprise Institute for Public Policy Research. National energy study 2)

...a study of the long-term effects of price controls imposed on the field market for natural gas by the Federal Power Commission."

Helms, Robert B.

Natural gas regulation: an evaluation of FPC price controls. Washington, American Enterprise Institute for Public Policy Research [c1974] 83 p. (American Enterprise Institute for Public Policy Research. National energy study 2)

Hittman Associates.

Study of the future supply of natural gas for electrical utilities. Columbia, Md. [Distributed by NTIS] 1972. 1 v. (various pagings)

"PB-209-285"

"The availability of natural gas as a low sulfur fuel for electrical production is examined in light of historical usage and availability. The goal was to ascertain not only near term but extended demands. Projections were made out through the year 2000. Such alternates as coal and oil shale gasification, Liquid Natural Gas (LGN), and well stimulation were evaluated."

Hodges, John E.

Natural gas: price regulation vs. supply. Austin, Bureau of Business Research, University of Texas at Austin, 1970. 24 p. (The Richard J. Gonzalez lectures, no. 3)

Hoffer, William.

Gas explosions: the rising toll. Washington post, Mar. 25, 1973, p. C5.

"In 1971, a total of 1,287 such accidents were reported to the Department of Transportation, tragedies in which 45 people were killed and 391 injured. And federal figures indicate that the death toll was higher for 1972."

Holles, Everett R.

U.S. companies and Soviet discuss a vast gas line. New York times, May 21, 1973, p. 1, 52.

Armand Hammer is negotiating a new pipeline deal with the Soviet Union. The pipeline project would be a joint venture of Occidental and the El Paso Natural Gas Company, and would involve construction of a 2,000-mile line from western Siberia to Murmansk to supply natural gas to the U.S.

Hough, Jack D. V., Jr.

Severance taxation in Oklahoma; potential revenue increases. Oklahoma business bulletin, v. 39, May 1971: 33-37.

Howell, Fred M. Merklein, H. A.

What it costs to find hydrocarbons in the U.S. World oil, v. 177, Oct. 1973: 75-79.

"Since 1938, finding costs have risen some 2,300%. Here's a late analysis of costs based on recent Joint Association Survey data."

Hughes, Peter C.

The natural gas shortage and deregulation. Washington, Heritage Foundation [c1974] 33 p. (Public policy studies, 3)

Industry braces for a natural gas crisis. Business Week, no. 2353, Oct. 19, 1974: 114-117.

"Some industry experts, predicting the most biting delivery cutbacks ever, believe that a severe winter will not only mean massive closing of plants but also perhaps the first curtailments of natural gas to homes."

Ingram, Timothy H.

Peril of the month: gas supertankers. Washington monthly, v. 4, Feb. 1973: 7-13.

Considers the hazards that might occur in any major collision, grounding, or spill following a harbor accident involving a supertanker convoying liquefied natural gas.

International Conference on Liquefied Natural Gas, 2d, Paris, 1970.

Second International Conference on Liquefied Natural Gas; [proceedings] [n.p., 1971] 1 v. (various pagings).

"Sponsored by International Gas Union, International Institute of Refrigeration, Institute of Gas Technology-Chicago."

"Second printing, this edition includes all papers printed originally in two volumes."

Interstate Oil Compact Commission. Legal Committee.

1972 legal report of oil and gas conservation activities. Oklahoma City, Okla. [1973] 43 p.

A state-by-state listing for those states which had significant legal activities in the field of oil and gas during 1972.

Interstate Oil Compact Commission. Legal Committee.

1973 legal report of oil and gas conservation activities. Oklahoma City [1974] 35 p.

A state-by-state listing for all states which had significant legal activities in the field of oil and gas during 1973.

Jacobsen, L. C.

Discovered but unproved gas reserves. Natural resources journal, v. 12, July 1972: 413-416.

Johnson, Thomas G.

The hearing under Section 7 of the Natural Gas Act--what now? Natural resources lawyer, v. 2, July 1969: 200-207.

"The philosophy of freezing gas prices, both for existing sales and for gas yet to be discovered for an indefinite time into the future, is not compatible with the operations of the gas industry, or the requirements of the gas consumer."

Jones, William K.

An example of a regulatory alternative to antitrust: New York utilities in the early seventies. Columbia law review, v. 73, Mar. 1973: 462-554.

Article examines the regulation of gas, electric, and telephone operations by the Public Service Commission of N.Y. State over the last several years.

Kalter, Robert J.

Economic analyses of fossil fuel markets using parametric models. Washington, Office of Policy Analysis/Economics, U.S. Dept. of the Interior [distributed by NTIS] 1973. 63 p.

Kansas. State Corporation Commission.

General rules and regulations for the conservation of crude oil and natural gas. [Topeka, 1973] 114 p.

Katzin, Jerome S. Lathrop, Patrick Siegler.

Funding LNG systems facilities. Public utilities fortnightly, v. 91, Mar. 15, 1973: 17-22.

"Examines the challenges of the liquefied natural gas industry and the different approaches to funding an LNG system."

Katzin, Jerome S. Lathrop, Patrick Siegler.

Funding LNG systems facilities. Public utilities fortnightly, v. 91, Mar. 15, 1973: 17-22.

"Much of the financing of investment in LNG system facilities will follow conventional lines. Major corporate participants, such as the utility companies and the transmission companies, will raise funds as part of their overall routine program of capital expansion. Political risks in the producing countries will necessitate heavy reliance on government-subsidized or guaranteed export financing."

Kauper, Thomas E.

National energy policy and the antitrust laws. Federal Bar journal, v. 32, winter 1973: 76-84.

Presents a general description of antitrust concerns and goals which have relevance to a number of energy industries. Briefly discusses two energy industries, natural gas and electric utilities. Article first presented as an address by the Assistant Attorney General (Antitrust Division) on June 4, 1973, before the Western Conference of Public Commissions, Portland, Oregon.

Kerr, James W.

New frontiers for natural gas. Conference Board record, v. 10, Jan. 1973: 54-56.

Notes a Canadian gas pipeline from the frontier or Arctic region may be realized by the end of the decade, but the cost of the gas from these areas will be substantially higher.

King, Frazier.

Public interest requires the authorization of importation of liquified natural gas as a supplemental supply to meet national and system-wide shortages if such is priced under a separate rate schedule and is the cheapest alternative supply. Virginia journal of international law, v. 13, spring 1973: 384-393.

This note discusses a recent FPC decision permitting the importation of LNG.

Kirk, Alan G., II.

Energy, the environment and the economy. American Gas Association monthly, v. 57, Jan. 1975: 18-21.

The Assistant Administrator for Enforcement and General Counsel, EPA, reviews the interdependency of energy, the environment and the economy.

Klass, D. L. Ghosh, S.

Fuel gas from organic wastes. Chemtech, Nov. 1973: 689-698.

Trash and garbage are really different kinds of solid waste. Authors explain how they can be combined to make substitute natural gas.

Kroeger, Carroll V.

A changing French gas industry. Energy pipelines and systems, v. 1, Apr. 1974: 32-34, 36.

Law, John.

An Arab-U.S. partnership that still works. U.S. news & world report, v. 76, Jan. 28, 1974: 32-34.

"In an atmosphere of business as usual, Algerians sell natural gas to the U.S., Americans explore the desert for oil wealth."

Lawrence, Floyd G. Miller, William H. Larsen, David H.

Will industry flicker as energy fades? Industry week, v. 174, Aug. 14, 1972: S1-S16.

Industry faces the possibility of energy rationing within the next decade. Natural gas and oil are the keys to the problem. Notes that if industrialization is to survive the decline of fossil fuels, other sources of energy are needed.

Lewers, Robert O.

Primary jurisdiction and the royalty owner: a misapplied doctrine. Southwestern law journal, v. 23, Aug. 1969: 454-487.

"It is submitted that the attempted application of a rule such as the primary jurisdiction doctrine, which provides for the allocation of jurisdiction over the substantive question of federal regulation over interstate gas royalty payments, is erroneous in settling the fundamental question of whether the Federal Power Commission has been granted jurisdiction by Congress in the Natural Gas Act over royalties due under a lease where the production has been sold in interstate commerce for resale. The fact is that either the Commission has by statute the exclusive jurisdiction in such cases, or it has no jurisdiction whatsoever, primary or otherwise."

The Liability of natural gas pipeline companies for breach of contract due to FPC-ordered curtailment. Duke law journal, v. 1973, Sept. 1973: 867-897.

Comment examines the effect of FPC gas regulation on private contracts to supply gas.

Linden, Henry R.

Current trends in U.S. gas demand and supply. Public utilities fortnightly, v. 86, July 30, 1970: 27-38.

"An up-to-date projection of potential gas supply deficiencies based on new statistics, including reserve and production data recently released."

Linden, Henry R.

SNG in the U.S. energy balance. Gas, v. 49, July 1973: 29-33.

Reviews the supply of substitute natural gas in the U.S. energy picture. First of two-part article.

Liversidge, Anthony.

Not enough gas in the pipelines. Fortune, v. 80, Nov. 1969: 120-122, 189-190.

"Natural gas now supplies one-third of the nation's energy requirements. But a prospective shortage of supplies may deflate expectations of an expansive future. And federal price regulation is not helping."

The LNG carrier: cashing in on the soaring demand for gas; a special report. Marine engineering/log, v. 77, Sept. 1972: 37-52, 112-113, 126, 128, 131.

Contents.--A product of the growing energy crisis.--Many cargo containment systems are available.--Gazocean's new ship hauls gas to Boston.--Barge will extend the oceangoing "pipelines".--El Paso ship is biggest of membrane type on order.--A big market for exotic, expensive materials.--Gas turbines for the gas tanker, by A. White.--The "boil-off": to burn or not to burn?--USCG role in LNG systems, by J. Kime.--ABS studing LNG designs, by C. Schoefer.

The LNG carrier: clean energy by the shipload. Marine engineering/log, v. 79, Oct. 1974: 35-59.

A review of the current state-of-the-art of ocean transport of LNG.

LNG report. Pipeline & gas journal, v. 201, June 1974: 27-32, 34, 36, 41-44, 46-47, 51, 54, 56, 58, 61.

Developments worldwide are detailed in report on new projects planned, proposed, and under construction.

Loehwing, David A.

Thrusting pipelines: they seek to bring Alaska's gas to users. Barron's, Apr. 14, 1975: 3, 20-21.

Discusses the impending struggle between two competing systems for bring Arctic natural gas to market.

Lorne, Simon M.

Natural gas pipelines, peak load pricing and the Federal Power Commission. Duke law journal, v. 1972, 1972: 85-113.

"The pricing structure appropriate for a firm which faces a peak load problem, as do most natural gas pipeline companies, has been subjected to a thorough examination in the economic literature over the past fifteen years. Unfortunately, that examination has been almost entirely theoretical, and has not been applied to the concrete problems faced by the Federal Power Commission in its task of regulating gas pipeline rates."

MacAvoy, Paul W.

The effectiveness of the Federal Power Commission. Washington, Brookings Institution, 1971. 271-303 p. (Brookings Institution, Washington, D.C. Reprint 189)

"This paper takes the view that the Federal Power Commission dispenses services that have measurable economic benefits and imposes the costs of these services on both the regulated firms and the final consumers of gas and electricity. An attempt is made to define and measure benefits from regulation at the margin, where this margin has been chosen by the Commission via present rulemaking and surveillance activities."

"Reprinted February 1971, with permission, from the BELL JOURNAL OF ECONOMICS AND MANAGEMENT SCIENCE, vol. 1, no. 2 (Autumn 1970)."

MacAvoy, Paul W.

The regulation-induced shortage of natural gas. Journal of law & economics, v. 14, Apr. 1971: 167-199.

"In the last few years there have been a number of indications of a serious shortage of natural gas reserves." Considers the size and source of excess demands.

MacAvoy, Paul W.

The regulation-induced shortage of natural gas. Washington, Brookings Institution, 1971. 167-199 p. (Brookings Institution, Washington, D.C. Reprint 214)

Argues that Federal Power Commission regulatory activities act to the advantage of industry and disadvantage of the consumer, and urges change in FPC regulation.

Macdonald, Donald S.

Canada to U.S. on oil: "we'll meet our own needs first"; interview. U.S. news & world report, v. 77, Oct. 28, 1974: 39-40, 42.

"American chances of getting major new oil supplies from north of the border aren't too encouraging. Canada's energy boss tells why..."

MacKenzie, John P.

Judging the judiciary. Progressive, v. 38, Aug. 1974: 18-21.

Weights the problem of judicial conflict of interests, focusing on the ownership of oil and gas securities by two of three Federal appellate judges of the Fifth Circuit hearing the 1969 Southern Louisiana gas rate case.

Mauze, James F. Smith, Don S.

Two sides of natural gas regulation. AGA [American Gas Association] monthly, v. 57, Feb. 1975: 11-14.

"A discussion of the authority state and federal regulators have on natural gas curtailments, allocation of supplies and rates."

McCaslin, John C.

Anadarko headlines superdeep U.S. drilling surge. Oil and gas journal, v. 68, Sept. 28, 1970: 29-32.

"The deep Anadarko basin has been chosen as the most likely place for the nation's next big gas domain..."

McCaslin, John C.

Natural gas: how much now and how much down the line. Oil & gas journal, v. 70, Apr. 17, 1972: 67-71.

A worldwide look at gas demand, production, reserves, and where and how much will be found in the future.

McDonald, Stephen L.

Incentive policy and supplies of energy sources. American journal of agricultural economics, v. 56, May 1974: 397-403.

"I shall concentrate on oil and gas, discussing both price and non-price incentives."

McDonald, Stephen L.

Public policy and the future adequacy of oil and gas supplies. Texas business review, v. 46, Aug. 1972: 163-168.

Briefly discusses policies with regard to oil and gas most likely to serve the Nation's interest. Paper presented on May 15, 1972 to the Forum on Energy Resources and Mineral Plant Foods sponsored by the National Materials Policy Commission, Austin, Texas.

McKeough, Kay.

LNG spells trouble. Environmental action, v. 6, Mar. 15, 1975: 10-13.

"While government agencies fight over which has authority to regulate importation of highly volatile liquid natural gas, the public is threatened with accidents which could kill thousands."

McKetta, John J.

The energy crisis: on and on and on. Chemical engineering progress, v. 69, Aug. 1973: 51-56.

"Predictions made in the past two or three years for 1985's energy outlook not holding up; energy problem seen as more severe than ever." Looks at each of the various sources and explains why each can't be depended upon to be a big factor in helping to solve the overall energy problem.

Meeks, James E. Landeck, Ronald J.

Area rate regulation of the natural gas industry. Duke law journal, v. 1970, Aug. 1970: 653-706.

Contents.--Economic overview of the natural gas industry.--A brief history of Federal regulation.--Regulation of rates prior to 1960.--The Permian Basin case.--Post-Permian developments.

Mehta, D. C. Crynes, B. L.

How coal-gasification common base costs compare. Oil and gas journal, v. 71, Feb. 5, 1973: 68-71.

"Coal gasification and conversion to methane offer one route for increasing the supply of gaseous energy. This article compares various coal-gasification processes under development."

Melicher, Ronald W.

Risk and return in the electric utility and natural gas industries. MSU business topics, v. 23, spring 1975: 48-54.

"In summary, as business and financial risk increased in the electric utility industry, returns to the common stockholders decreased. With this type of risk-return relationship, it is no wonder that electric utilities are finding it difficult to maintain and attract equity capital. The prevailing situation can be remedied only by improving the quality of incomes and earnings, lowering financial leverage ratios, and increasing the rates of return on common equities."

Merklein, H. A.

Alternate fossil fuels won't add much to U.S. energy supply. World oil, v. 179, Aug. 1, 1974: 27-32.

"This candid appraisal of the potential of gas and/or oil derived from assisted recovery processes applied to existing reservoirs, shale, tar sands and coal indicates the future is not bright."

Methanol versus LNG. Petroleum press service, v. 40, Feb. 1973: 61-63.

"The conversion of natural gas to methanol--the simplest of the alcohols--is currently being suggested as a cheaper means of shipping energy to distant markets than that offered by costly gas liquefaction projects."

Metz, William D.

Power gas and combined cycles: clean power from fossil fuels. Science, v. 179, Jan. 5, 1973: 54-56.

"To meet increasing demand for electricity in the next few years, combined gas and steam cycle systems offer a relatively cheap and--more importantly--immediately available option."

Metzger, Peter.

Project Gasbuggy and Catch-85. New York times magazine, Feb. 22, 1970: 26-27, 79, 84.

In Colorado, "citizens have brought suit to enjoin the A.E.C. from flaring contaminated natural gas...from a well triggered by an underground nuclear explosion."

Mintz, Morton.

...Where price controls are still needed. Washington monthly, v. 6, May 1974: 29-37.

"The basic question about natural gas is which system--the free market or government regulation--will best serve the two ends of providing an adequate supply of natural gas, and doing so at the lowest reasonable price."

Mitchell, Edward J.

U.S. energy policy: a primer. Washington, American Enterprise Institute for Public Policy Research [1974] 103 p. (American Enterprise Institute for Public Policy Research. National energy study 1)

Argues that Americans are suffering from a seesawing policy of government intervention in the energy market. Focuses on the petroleum and natural gas industries.

Moody, Rush, Jr.

Decontrol--end of a noble experiment? Public utilities fortnightly, v. 92, Oct. 25, 1973: 20-23.

"Wellhead price regulation of natural gas has been given a 19-year test period. Surely it is not precipitous to ask, after nineteen years, whether or not this noble experiment has been successful."

Moody, Rush, Jr.

Regulating price of natural gas. American Gas Association monthly, v. 55, Nov. 1973: 28-30.

"Commissioner of the Federal Power Commission presents his opinions on price regulation and its effects on supply and demand."

National Association of Regulatory Utility Commissioners.

Natural gas allocation and curtailment procedures. Washington, 1974. 14 p.

National Association of Regulatory Utility Commissioners. Subcommittee on Gas.

Survey of action by state regulatory agencies and interstate natural gas distributors to meet natural gas shortages. [Washington] 1974. 87 p.

National Industrial Pollution Control Council.

One ecology answer to energy need--more natural gas. Commerce today, v. 2, Aug. 21, 1972: 4-8.

"Cleanest fossil fuel could eliminate much pollution, if there were enough." "With the potential for vast supplies of natural gas, there can only be one answer--develop the means and incentives to find it."

National Industrial Pollution Control Council. Utilities Sub-Council.

The natural gas industry and the environment. [Washington, For sale by the Supt. of Docs., U.S. Govt. Print. Off.] 1972. 20 p.

"Although a serious natural gas shortage appears imminent, there exists a paradox. 'How can there be an actual shortage amidst a domestic potential of plenty?' Estimates of potential supplies in the United States range upward from 1100 trillion cubic feet. This compares with the 247 trillion cubic feet of proved reserves on which the present industry investment is based. The gas industry is confident that this tremendous domestic potential can be developed by aggressive industrial action augmented by government cooperation and assistance."

National Petroleum Council. Committee on U.S. Energy Outlook.

U.S. energy outlook; a report. [Washington] 1972. 381 p.

National Petroleum Council. Committee on U.S. Energy Outlook.

U.S. energy outlook: an initial appraisal 1971-1985; an interim report. Volume 2. [Washington] 1971. 195 p.

"...Volume Two of a two-volume interim report prepared by the National Petroleum Council, representing an initial appraisal of the energy outlook of the United States. Volume one of the interim report, dated July 15, 1971, projects supply/demand relationships for the period 1971-1985...Volume Two of the interim report contains summaries of the reports made by the various fuel task groups."

National Petroleum Council. Committee on U.S. Energy Outlook. Gas Demand Task Group.

U.S. energy outlook: gas demand. [Washington, c1973] 50 p.

Discusses "the many factors influencing the demand for utility pipeline gas in the United States during the 1970-1985 period."

National Petroleum Council. Committee on U.S. Energy Outlook. Gas Subcommittee. Gas Transportation Task Group.

U.S. energy outlook: gas transportation; a report. [n.p., c1973] 219 p.

"...analyzes the capital costs of transporting, processing, and storing gas for the years 1971 to 1985. Four general types of gas are analyzed: natural gas, liquefied natural gas (LNG), substitute natural gas (SNG), and liquefied petroleum gas (LPG).

National Research Council. Ad Hoc Panel on Evaluation of Coal-Gasification Technology.

Evaluation of coal-gasification technology; part 2, low- and intermediate-BTU fuel gases. [Washington, Office of Coal Research] 1974. 91 p. (U.S. Office of Coal Research. R & D report no. 74--interim report no. 2)

National Research Council. Ad Hoc Panel on Evaluation of Coal-Gasification Technology.

Evaluation of coal-gasification technology; part 1 pipeline-quality gas. Washington, For sale by the Supt. of Docs., U.S. Govt. Print. Off. [1973] 80 p. (U.S. Office of Coal Research. R & D report no 74 - interim report no. 1) Bibliography, p. 77-80.

Natural gas: its impact on the energy market in OECD Europe. OECD observer, no. 42, Oct. 1969: 37-41.

Natural gas--pipeline industry responds to challenge of declining reserves. Federal Reserve Bank of Dallas business review, Oct. 1974: 1-11.

Natural gas processing; a special report. Oil and gas journal, v. 71, July 9, 1973: 87-114.

Contents.--Energy crises brings problems, opportunities to gas processors, by R. E. Cannon.--Gas capacity is down; liquid recovery is up, by G. L. Farrar.--1973 survey of gas-processing plants, by Aileen Cantrell.

Natural gas processing. Oil & gas journal, v. 72, July 8, 1974: 53-60, 65, 67-68, 70, 74, 76, 80.

Contents.--Gas processors wary of forecasts--warier still of regulatory snarls, by R. Cannon.--International LP-gas supply--will there be enough?, by R. Gresimer.--U.S. LP-gas supply has potential for increase, by E. Kilgren and T. Doss.--Gas capacity is up; throughput, liquids down, by G. Farrar.

Natural gas shortage: deepening crisis. Magazine of Wall Street, v. 127, Apr. 24, 1971: 22-24, 36-37.

"Combination of strong demand for gas plus U.S. shortage of supply and Canadian abundance puts a new focus on several companies."

Natural-gas squeeze--how tight will it get? U.S. news & world report, v. 78, Feb. 3, 1975: 47-48.

"For now, some hard-pressed factories are getting gas needed to stay open, avoid layoffs. But fresh reports tell the story: The future is uncertain."

New York (State). Dept. of Public Service. Gas Division.

Gas supplies for U.S. consumers. Albany, 1971. 61 p.

"The purpose of this report is to review the present gas supply situation for U.S. consumers. The statistical information was derived from government and industry publications and formal proceedings before the Federal Power Commission."

Nordlinger, Stephen E.

Taking the lid off natural gas. Progressive, v. 38, Mar. 1974: 23-26.

"Removing control of natural gas prices could increase the industry's sales income by \$12.5 billion a year."

O'Connor, Lawrence J., Jr.

Gas supply and the role of the independent producer.
Public utilities fortnightly, v. 84, Oct. 23, 1969: 26-33.

"A better understanding of the common problem facing the production, transmission, and distribution segments of the industry is required if the supply situation is to be properly defined, analyzed, and overcome."

O'Connor, Lawrence J., Jr.

Reflections on ten years of natural gas producer price regulation. Public utilities fortnightly, v. 88, Oct. 14, 1971: 26-31.

Reviews what producers, pipelines, distributors, and the courts have, or have not, done in support of higher prices since 1960.

Offshore oil and gas production: annual review. Offshore, v. 33, June 20, 1973: 84-198.

Contents.--Western Hemisphere--Gulf of Mexico, offshore Louisiana, U.S. West coast, Latin America, Canada.--Eastern Hemisphere--Africa, Australia, Middle East, Mediterranean, Mainland China, North Sea, Scotland, England, Southeast Asia, Russia.

Ogden, William J.

Natural gas legislation. Public utilities fortnightly, v. 93, Mar. 14, 1974: 20-24.

"Policy with regard to natural gas, a prime energy source, seems to have been assigned a low priority."

Oklahoma. University. Science and Public Policy Program.
Technology Assessment Group.

Energy under the oceans: a technology assessment of outer continental shelf oil and gas operations. [1st ed. Norman, University of Oklahoma Press, 1973] 378 p.

Oklahoma. University. Science and Public Policy Program.
Technology Assessment Group.

Energy under the oceans: a summary report of a technology assessment of OCS oil and gas operations. [1st ed. Norman, University of Oklahoma Press, 1973] 31 p.

"The complete report, Energy Under the Oceans: A Technology Assessment of Outer Continental Shelf Oil and Gas Operations, was published by the University of Oklahoma Press in September, 1973."

Oregon. Governor Tom McCall's Task Force on Energy.
Oregon's energy perspective. [Salem] 1973. 138 p.
Partial contents.--Brief history of Oregon energy.--
Pacific Northwest hydro assessment.--Assessment of the oil
situation.--Oregon's national gas situation.--Summary of
Oregon's energy systems.

Parson, Daniel.

Gas vs. electricity: an energy conservation issue.
Pipeline & gas journal, v. 201, Feb. 1974: 54, 56, 58.
"With natural gas becoming increasingly more valuable,
'national policy' should be concerned with elimination of
'wasteful' applications of fuel resources--such as using it as
a boiler fuel, says P&GJ's consulting editor."

Perry, Bradley W.

The short-run consequences of increased energy cost: an
input-output approach. Energy systems and policy, v. 1, fall
1974: 65-79.

"The input-output technique is used to estimate the
effects of price increases in two energy resources: crude oil
and natural gas."

Perry, Stuart.

'Gassing up' for plunder in the tundra. Environmental
action, v. 6, Dec. 18, 1974: 3-6.

Controversy has arisen over the transport of North Slope
gas via a trans-Canada pipeline.

Petrochemical Energy Group.

Comments of the Petrochemical Energy Group on the
mandatory fuel allocation program for propane proposed by
Energy Policy Office. [n.p.] 1973. 1 v. (various pagings)

Phillips, James G.

Congress nears showdown on proposal to decontrol gas
prices. National journal reports, v. 6, May 25, 1974: 761-775.

"The attempt to end federal regulation of natural gas
prices seems destined to fail again this year despite the
increased impetus provided by the energy shortage."

Phillips, James G.

Major industrial users threatened by natural gas shortage. National journal reports, v. 6, Sept. 14, 1974: 1380-1384.

"Prospective shortages of natural gas for the coming winter that are almost twice as severe as last year's shortages are causing a flurry of activity as industries seek to assure themselves of adequate supplies.... Hardest hit by the expected shortages are areas along the East Coast around the Great Lakes."

Potential Gas Committee.

Potential supply of natural gas in the United States; (as of December 31, 1968). [n.p., 1969] 39 p.

"Sponsored by Potential Gas Agency, Mineral Resources Institute, Colorado School of Mines Foundation, Inc., Golden, Colorado.

"This report by the Potential Gas Committee is the third biennial industry self-estimate of the potential supply of natural gas in the United States."

Potential Gas Committee.

Potential supply of natural gas in the United States (as of December 31, 1970). [Golden, Colo., 1971] 41 p.

"Sponsored by Potential Gas Agency, Mineral Resources Institute, Colorado School of Mines Foundation, Inc., Golden, Colorado."

Rankin, Alex.

Natural gas report '75: decision year for gas industry. Oilweek, v. 25, Jan. 20, 1975: 12-46.

"Increased gas plant construction and rising sulphur sales this year are two highlights of Oilweek's annual natural gas report." Also, includes a comprehensive listing of natural gas processing plants.

Raw materials: you get what you pay for. Forbes, v. 108, Aug. 1, 1971: 20-25.

"Few people realize how self-sufficient the U.S. has been in its raw material position. Until two years ago, we were, on balance, able to extract from our own reserves sufficient supplies of the energy fuels, oil and gas, coal and uranium, to meet the needs of both industry and the general public. In our other major raw materials, our self-sufficiency has been somewhat less complete... Now this advantage is slowly slipping away."

Rebman, John R.

Public Land Law Review Commission report--impact on the natural gas industry. Natural resources lawyer, v. 4, Jan. 1971: 216-221.

A member of the Natural Resources Law Section of the American Bar Association makes some observations concerning the natural gas and right of way aspects of the Public Land Law Review Commission report.

Rensch, Joseph R.

The emerging partnership of coal and gas. Public utilities fortnightly, v. 90, Oct. 26, 1972: 34-40.

A roundup of the trends in supply and demand and a number of emergency potential solutions on many fronts.

Renshaw, Edward F.

How to ration dwindling gas supplies. Public utilities fortnightly, v. 95, May 8, 1975: 27-29.

Ridgeway, James.

Gas battle of Algiers. Ramparts, v. 10, Mar. 1972: 18, 20.

"El Paso Natural Gas Company's plan to buy large quantities of gas from Algeria for shipment to the east coast of the U.S. has important political consequences."

Ridgeway, James.

Notes on the energy crisis. Ramparts, v. 12, Oct. 1973: 37-41.

Analysis holds there is good reason to suspect the energy industry's scare campaign about the current "crisis." But there is a real energy problem, which the petroleum industry is bent on turning to its own advantage.

Roberts, Marc J.

Is there an energy crisis? Public interest, no. 31, spring 1973: 17-37.

Partial contents.--Putting the question properly.--Current shortages--gas, oil, and electricity.--Environmentalism--obstacle or opportunity.--Clean energy--scarce or just more expensive?--Power plant controversies.--It's chic to fear the sheiks.

Rocky Mountain Petroleum Economics Institute, Colorado Springs, 1969.

The political economy of energy and national security. Golden, Colorado School of Mines, 1969. 218 p. (Colorado School of Mines, Golden. Quarterly v. 64, no. 4)

Partial contents.--The role for oil and gas in national security, a government view, by R. T. Mathews.--Some dimensions of Middle East oil: the producers and the U.S., by Ragaei El Mallakh.--The potential roles of Canadian oil and gas, other Western Hemisphere oil and Eastern Hemisphere oil in U.S. markets, 1965-1985, by Milton Lipton and R. F. Kilgore.--Federal public lands leasing policies, by W. J. Mead.

Rogers, Walter E.

Is there a national shortage of gas in our future? Public utilities fortnightly, v. 85, Mar. 26, 1970: 17-22.

"The author says the natural gas supply situation is one of the more pressing problems of the industry."

Rogers, William B. Fakundiny, Robert H. Kreidler, W. Lynn.

Petroleum exploration offshore from New York. Albany, University of the State of New York, State Education Dept., 1973. 25 p. (New York (State). State Museum and Science Service. Circular 46)

Evaluates the potential geologic hazards that might contribute to an oil spill while drilling and developing petroleum and natural gas reserves offshore from the New York area.

Rose, Sanford.

Our vast, hidden oil resources. Fortune, v. 89, Apr. 1974: 104-107, 180, 182, 184.

"The industry is capable of a phenomenal explosion of output within the next three years. To set off this explosion, all we have to do is shed some large misconceptions about the economics of oil supply and about the geology of oil reserves. The 'we' in this case includes a fair number of oil producers and government regulators."

Rossmann, Joseph E., Jr.

Louisiana and the energy shortage. Federal Reserve Bank of Atlanta monthly review, v. 55, Feb. 1975: 14-17.

"...our analysis indicates that Louisiana did not escape energy-related problems and, in some instances, felt fuel shortages as severely as the rest of the nation."

Rudkin, R. Alan.

Petroleum potential of Arctic Canada. Journal of petroleum technology, v. 26, Feb. 1974: 143-149.

"An estimated 18 percent of the world petroleum potential north of the 60th parallel lies in the sedimentary basins of the Canadian Arctic. Little oil has been discovered, but significant gas reserves have been found in the Beaufort basin and the Arctic Islands, and with expected large discoveries in the next 2 years, gas from the Beaufort basin should be available to southern markets by 1980."

Runyon, Richard P. Rocks, Lawrence.

The energy crisis in the cold war. National review, v. 25, Mar. 2, 1973: 255-258.

"Why is the Soviet Union being so agreeable about sharing its energy resources with us? The authors discuss the Soviet strategy, point out its dangers, and offer an alternative."

Ryan, Robert H.

Texas energy industries, 1972. Texas business review, v. 46, June 1972: 120-125.

"Though there is no prospect that Texas will need imported gas or SNG in the immediate future, it will be a stroke of good fortune if nuclear-energy technology develops rapidly enough to fill the growing energy needs before short supplies and rising prices of gas inflict a serious economic squeeze on the state's utilities and manufacturing industries."

Saikowski, Charlotte.

Billions at stake in U.S.-Soviet natural gas deal. Christian Science monitor, Nov. 8, 1972, p. 1, B10.

"A preliminary deal is reported near for the import of natural gas from the Soviet Union's huge deposits in Siberia." Two separate 25-year projects are involved in the talks between the Soviet Government and the private companies.

Scheibla, Shirley.

Distrigas vs. the FPC: the case concerns all regulated enterprise. Barron's, Dec. 31, 1973, p. 9, 24, 26.

"Distrigas Corp., owned by Cabot Corp., is a pioneer in a new industry--the import, storage, regasification and sale of liquid natural gas (LNG)." At this point Distrigas doesn't know if its facilities will fall under Federal regulation. FPC has "reversed a presumably non-appealable order."

Scheibla, Shirley.

The FPC has produced no solution to the shortage of natural gas. Barron's, v. 50, June 1, 1970: 5, 19-20.

FPC Commissioner Carl E. Bagge wants "...to make the public aware of the impending very serious national shortage of natural gas due to the Commission's control of producer prices." Discusses the problems involved in the impending natural gas shortage.

Scheibla, Shirley.

Heat on FPC: higher prices for natural gas won't come easy. Barron's, July 2, 1973, p. 5, 17.

"After 18 years of regulation, the producer does not know how much it can lawfully charge for natural gas in interstate commerce nor how much it will get if it develops and sells new gas to the interstate market."

Schleicher, A. R.

The environmental impact concept. American Gas Association monthly, v. 56, Apr. 1974: 21-25.

"Terminology, legislation, and research are basic elements in preparing an environmental impact assessment. A. R. Schleicher, Southwest Research Institute, explains what is required and the procedures involved in relation to the natural gas industry."

Schmidt, Jerold L.

Do industrial natural gas sales benefit other consumers. Public utilities fortnightly, v. 94, Oct. 24, 1974: 23-28.

"Changes in the consumer mix of gas utilities will have an impact on rates. But maybe less than feared."

Schneider, A. Patrick, II. Mason, Gene L. Langan, Thomas J.

Texas Gas vs. Kentucky farmers. Ramparts, v. 10, Feb. 1972: 20, 22, 24, 58-59.

Accuses the Texas Gas Transmission Corp. of illegally and fraudulently forcing Kentucky landowners to sell their land at low prices under threat of condemnation suit.

Sharpe, Howard.

Bottleneck industries: deregulation of natural gas could spark higher profits. Commercial and financial chronicle, v. 219, Sept. 2, 1974: 1, 3, 14.

"The estimated 1975 per share profits of some domestic and international oil companies involved in natural gas production could swell by more than 100 per cent if the pre-June 1974 price of interstate gas at the wellhead is allowed to rise to intrastate levels."

Sherrill, Robert.

'Energy crisis!' The industry's fright campaign. Nation, v. 214, June 26, 1972: 816-820.

Holds that the energy crisis, to a large extent, was generated by the industry's propagandists.

Sherrill, Robert.

Nassikas sets your gas bill. Nation, v. 214, Jan. 17, 1972: 73-79.

An article about the Chairman of the Federal Power Commission and the FPC's role in regulating the sale and distribution of natural gas. Believes the FPC has become too pro-industry.

Signing near for big Russian LNG deal. Oil & gas journal, v. 70, Nov. 13, 1972: 97-99.

"Texas Eastern consortium expects to sign contract in next 2 months which would ship 2 billion cfd of Soviet gas to U.S. in return for \$12.5 billion in goods, services. Second trade under negotiation."

Singer, Fred.

Fuel: what kind and from where. Washington star, Mar. 4, 1973, p. E3.

The author, a professor of environmental sciences at the University of Virginia and a consultant on energy matters, notes that the energy crisis is really three crises. Before drafting new policies, he feels national goals should be considered. Finally, he discusses the shortages of natural gas and heating oil.

Sivewright, Sandy.

LNG--cargo for the 1970s. New scientist, v. 54, June 15, 1972: 610-612.

"As natural gas begins to rival oil as fuel, the business of shipping it in liquid form (LNG) across the globe promises to alter the pattern of international shipbuilding. For once, with the cryogenic know-how residing mostly in the West, Japanese shipbuilders cannot yet compete with yards in Europe and the US."

Smith, Robert.

Canadian gas export policy. Public utilities fortnightly, v. 86, Nov. 5, 1970: 23-27.

"A review, from a Canadian's viewpoint, of the availability of natural gas supplies, including those from nondomestic sources, such as those from Canada."

Smith, Robert.

Canadian gas export policy--an updating. Public utilities fortnightly, v. 89, Feb. 3, 1972: 40-42.

"An explanation of the recent decision of the Canadian National Energy Board in turning down applications by various pipeline applicants seeking to export natural gas to the U.S. market."

SNG: how much, at what cost, how soon in U.S.? Oil & gas journal, v. 69, Dec. 6, 1971: 31-36.

A brief review of the current situation with a table on "U.S. liquid-hydrocarbon gasification projects and where they stand."

Starratt, Patricia E.

The natural gas shortage and the Congress. Washington, American Enterprise Institute for Public Policy Research [1974] 68 p. (American Enterprise Institute for Public Policy Research. National energy study 5)

Starratt, Patricia E.

We're running out of gas--needlessly. Reader's digest, v. 102, Apr. 1973: 167-168, 170, 172.

"Thanks to inept government regulation and unthinking environmental protest, our cheapest, cleanest fuel is becoming increasingly unavailable."

Stone, Oliver L.

Continental shelf natural gas, including a comparison of significant features of the systems of the United States and the United Kingdom. Natural resources lawyer, v. 4, Nov. 1971: 809-828.

Stowe, William S.

Conservation and the commission: the growth of regulation of the end use of natural gas by the Federal Power Commission. Environmental affairs, v. 3, no. 3, 1974: 527-562.

Swanick, Eric L.

The energy situation: crisis and outlook, an introductory non-technical bibliography. Monticello, Ill., 1975. 34 p. (Council of Planning Librarians. Exchange bibliography 742)

Swanson, Dwight H.

A responsible energy strategy--1974, "a year of begining."

Public utilities fortnightly, v. 93, May 9, 1974: 21-25.

"The energy industry must discover new methods of managing the task of providing adequate supplies of all kinds of energy during 1974." Gives an extensive discussion of natural gas supply problems.

Tarling, D. H.

Continental drift and reserves of oil and natural gas.

Nature, v. 243, June 1, 1973: 277-279.

"Any new concept which is likely to assist in the location and assessment of the remaining reserves of oil and hydrocarbon gas is of obvious importance so it is opportune to use reviews of the conditions of formation of the principal hydrocarbon sources and their subsequent migration and preservation in reservoirs to see how these are related to movements of the Earth's surface."

Thomas, Dana L.

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Tybout, Richard A.

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"Serial no. 93-70"

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Conflict of interest, emergency gas sales, and other internal procedures of the Federal Power Commission. Hearings, 93d Cong., 2d sess. Washington, U.S. Govt. Print. Off., 1975. 529 p.

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"Serial no. 92-1"

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At head of title: 92d Cong., 2d sess. Committee print.

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The energy crisis and proposed solutions; prepared statements presented in panel discussions by administration officials. Washington, U.S. Govt. Print. Off., 1975. 85 p.
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 S. 2305, S. 2506. Parts 1 and 2. Washington, U.S. Govt.
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 2d sess., on S. Con. Res. 31, S. 992, S. 1829, S. 2048, S.
 2143, S. 2305, S. 2506, and amendments. Washington, U.S. Govt.
 Print. Off., 1974. 3 v.
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 1974.
 "Serial no. 93-63"

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 1974; report on S. 2532. Washington, U.S. Govt. Print. Off.,
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 Federal Power Commission oversight-natural gas curtailment
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Cong., 1st sess. Senate. Report no. 94-191)

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products at reasonable prices to the consumer, and for other
purposes."

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2d sess. Jan. 30, 1970. Washington, U.S. Govt. Print. Off.,
1970. 774 p.
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projections of power industry growth; environmental
considerations; reliability policy and organizations; state and
interstate authorities and activities relating to power plant
siting; takeover or relicensing of hydroelectric projects;
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regulation of the electric power industry under parts II and
III of the Federal Power Act.

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Subcommittee on Multinational Corporations.

U.S. trade and investment in the Soviet Union and Eastern Europe: the role of multinational corporations; a staff report. Washington, U.S. Govt. Print. Off., 1974. 45 p.

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U.S. Congress. Senate. Committee on Interior and Insular Affairs.

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Parts 1 and 2 contain hearings held Feb. 1 and 22, 1973, in Washington, D.C. Part 3 contains hearings held May 25, 1973, in Sioux Falls, S. Dak.

U.S. Congress. Senate. Committee on Interior and Insular Affairs.

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Hearings held Feb. 25...Mar. 2, 1972.

"Serial no. 92-22"

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U.S. Congress. Senate. Committee on Interior and Insular Affairs.

U.S. energy resources, a review as of 1972; a background paper...pursuant to S. Res. 45, a national fuels and energy policy study. Washington, U.S. Govt. Print. Off., 1974. 267 p.

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Paper was prepared by M. King Hubbert, Research Geophysicist, Office of Energy Resources, Geological Survey.

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Nuclear stimulation of natural gas. Hearing, 93d Cong., 1st sess. May 11, 1973. Washington, U.S. Govt. Print. Off., 1973. 889 p.

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Energy perspectives: a presentation of major energy and energy-related data. [Washington, For sale by the Supt. of Docs., U.S. Govt. Print. Off., 1975] 207 p.

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Deregulation of natural gas prices; final environmental impact statement. Washington, For sale by the Supt. of Docs., U.S. Govt. Print. Off., 1974. 1 v. (various pagings)

U.S. energy resources; underdeveloped, over-regulated, wastefully used. Coal age, v. 79, Apr. 1974: 69-116.

A joint report by the editors of COAL AGE and ENGINEERING AND MINING JOURNAL. Also appears in ENGINEERING AND MINING JOURNAL, April 1974.

Partial contents.--The quest for US energy sufficiency.-- Why is the US faced with an energy shortage?--New processes brighten prospects of synthetic fuels from coal.--Oil shale...a rapidly emerging industry.--Nuclear power...domination by year 2000.--Other technical concepts are exciting, but their roads to power are long.

U.S. faces natural gas crisis. Petroleum press service, v. 39, Jan. 1972: 11-15.

"For the past three years, the US has been consuming more natural gas than has been discovered. Reserves have now reached danger levels and shortages are already being experienced. This first of two articles deals with the background to the problem; the second will show what is being done to help solve it."

U.S. Federal Council for Science and Technology.

Extraction of energy fuels. [Washington, Distributed by NTIS] 1972. 252 p.

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Contents.--Electric power.--Natural gas.

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1972 fifty-second annual report: Federal Power Commission. Washington, For sale by the Supt. of Docs., U.S. Govt. Print. Off. [1973] 113 p. (93d Cong., 1st sess. House. Document no. 93-17)

U.S. Federal Power Commission.
1973 fifty-third annual report. Washington, For sale by
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An informal explanation of the organization and work of
the Federal Power Commission. [Washington, 1971] 39 p.

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Docs., U.S. Govt. Print. Off., 1973 [i.e. 1974] 383 p.
Vol. IV--Report of the Executive Advisory Committee to the
Federal Power Commission: summary report of the Distribution-
Technical Advisory Committee to the Executive Advisory
Committee; Distribution-Technical Advisory Task Force reports
to the Distribution-Technical Advisory Committee; general,
facilities, finance, regulation and legislation.

U.S. Federal Power Commission.
Opinion and order prescribing uniform national rate for
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January 1, 1973, and new dedications of natural gas to
interstate commerce on or after January 1, 1973. [Washington]
1974. 1 v. (various pagings) (U.S. Federal Power Commission.
Opinion no. 699)

"In this proceeding, we establish a single uniform
national base rate of 42.0 cents per Mcf..."

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companies, 1969. Washington, For sale by the Supt. of Docs.,
U.S. Govt. Print. Off. [1971] 150 p.

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The gas supplies of interstate natural gas pipeline
companies, 1973. Washington, For sale by the Supt. of Docs.,
U.S. Govt. Print. Off. [1975] 127 p.

U.S. Federal Power Commission. Bureau of Natural Gas.
Preliminary staff report on investigation of disaster at Texas Eastern Transmission Corporation LNG storage tank on Staten Island, Borough of Richmond, New York City, New York, February 10, 1973. Washington, 1973. 1 v. (various pagings)

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A staff report on national gas supply and demand. Washington, 1969. 110 p.
References, p. 107-110.

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Sales by producers on natural gas to interstate pipeline companies, 1972. Washington, For sale by the Supt. of Docs., U.S. Govt. Print. Off., 1974. 731 p.

U.S. General Accounting Office.
How the Federal Government participates in activities affecting the energy resources of the United States; report to the Congress by the Comptroller General of the United States. [Washington] 1973. 42 p.
"B-178205, Apr. 6, 1973"

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"B-180228, Sept. 13, 1974"

U.S. Interagency Task Force on Natural Gas.
Natural gas. [Washington] Federal Energy Administration [for sale by the Supt. of Docs., U.S. Govt. Print. Off.] 1974. 1 v. (various pagings)
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Projects "alternative future levels of non-associated gas production and the capital, manpower and materials associated with these levels of resource development."

U.S. Laws, statutes, etc.
Compilation of Federal laws relating to fuel and energy resources. Prepared for use of the Committee on Interior and Insular Affairs of the U.S. House of Representatives, Ninety-second Congress. Washington, U.S. Govt. Print. Off., 1972. 898 p.
At head of title: 92d Cong., 2d sess. Committee print 92-7.

U.S. Library of Congress. Science Policy Research Division.
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the Committee on Science and Astronautics, U.S. House of
Representatives. 93d Cong., 1st sess. Washington, U.S. Govt.
Print. Off., 1973. 539 p.

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extensive U.S. and foreign energy statistics, together with an
extensive index.

U.S. President, 1969- (Nixon).

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Govt. Print. Off., 1973. 17 p. (93d Cong., 1st sess. House.
Document no. 93-85)

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v. 39, Feb. 1972: 43-46.

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shortage in the U.S., various ways of ensuring future supplies
are considered."

Vadgama, Usman N. Hinkle, Bill B.

Exploration and production economics of low-permeability
shallow gas formations in Appalachia. Journal of petroleum
technology, v. 26, Sept. 1974: 985-989.

Vielvoye, Roger. Hill, Peter.

Liquefied natural gas; a special report. Times (London),
Aug. 16, 1972, p. i-iv.

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domestic supplies. The United States and Japan are today major
customers for low-pollution fuel. In this Special Report Roger
Vielvoye and Peter Hill of THE TIMES industrial staff review
LNG schemes and finance, markets and prices, production and
shipbuilding developments, and assess the prospects of this
important industry."

Walter, Norma.

Is there a natural gas shortage? Exchange, v. 31, Sept.
1970: 1-8.

"The gas is in the ground, but producers claim that the
financial incentive to go out and find it is missing. So, it's
a pretty sure thing that natural gas prices are going to be
increased..."

Weaver, O. D. Calvert, W. I. McGuire, W. H.

Appalachia--part I: a new look at the gas and oil potential of the Appalachian basin. Oil and gas journal, v. 70, Jan. 17, 1972: 126, 128-130.

"More than a dozen major oil and gas companies and large independent operators have instigated a series of aggressive exploration programs because of the literally millions of acres within the basin over which neither seismic crews have been dispatched nor test well drilled to the thick (10,000-25,000 ft) relatively untested clastic and carbonate sections of lower Paleozoic strata that underlie over 75% of the basin's geographical extent."

Weber, George.

Gas pinch, higher prices to change energy patterns. Oil & gas journal, v. 70, Oct. 16, 1972: 73-76.

Wheatley, Charles F., Jr.

Natural gas: crisis in regulation. Public power, v. 29, Mar.-Apr. 1971: 20-23.

"The United States now faces a major crisis over the effective regulation of natural gas essential to our economy. In my view, the real crisis is one of 'effective regulation' not that of a 'gas shortage.'"

While U.S. needs mount--a new fight over Arctic fuel. U.S. news & world report, v. 78, Jan. 13, 1975: 61-62.

"Far to the north, there's plenty of natural gas to ease a growing shortage. Problem to be settled is how to get it to markets in the U.S."

White, I. C.

The waste of our fuel resources. [Morgantown] West Virginia Geological and Economic Survey, 1972. 19 p. (West Virginia. Geological Survey. Environmental geology bulletin no. 9)

Discusses the waste of our natural gas, petroleum, and coal resources.

Whittemore, F. Case.

How much in reserve? Environment, v. 15, Sept. 1973: 16-20, 31-35.

"This article seeks to compare the methods of estimating the major fuel resources (coal, oil, gas, and uranium) with the hope that such a comparison will provide better understanding of the strengths and weaknesses of current methods of estimating these resources."