PETROLEUM STORAGE:

ALTERNATIVE PROGRAMS AND THEIR IMPLICATIONS FOR THE FEDERAL BUDGET

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PREFACE

The Energy Policy and Conservation Act (EPCA) of 1975 requires the Federal Energy Administration to submit plans to implement a national strategic petroleum reserve mandated by the Act. This paper provides background information and analysis relevant to the potential budget impact of those implementation plans. The paper was prepared to provide documentation, elaboration, and modification of material originally presented in CBO's Annual Report. In keeping with the Congressional Budget Office's mandate to provide non-partisan analysis of policy options, no recommendations are presented. The report was prepared by Reginald Brown of CBO's Natural Resources and Commerce Division under the direction of Douglas M. Costle and Nicolai Timenes, Jr. Editorial Assistance was provided by Katharine T. Bateman. Staff support in preparation of the paper was provided by Angela Z. Evans.

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CONTENTS

TABLES

FIGURES

SUMMARY

The Energy Policy and Conservation Act of 1975 (EPCA) mandates creation of a U.S. strategic petroleum reserve, consisting of petroleum held in man-made storage facilities for rapid and easy access in time of emergency. The primary purpose of such a reserve is to protect the United States from the economic impact of an abrupt interruption in the flow of imported petroleum products. In addition, a large inventory of. stored petroleum could permit the government to participate directly in petroleum markets for price stabilizing purposes.

The architects of the EPCA specified creation of a reserve in two stages: (1) an early stage, to be completed by December 1978, at a minimum level of 150 million barrels and (2) a follow-on stage, to be completed by December 1982, which could bring total stored petroleum to a minimum of just under 500 million barrels. The act states that U.S. policy is to provide storage for up to one billion barrels of petroleum products, but not less than 150 million barrels.

The Administrator of the Federal Energy Administration (FEA) was charged with submitting, in March 1976, a plan for the first phase, and by December 1976, plans for the follow-on stage of the program. The first-stage plan, called the "early storage reserve plan" (ESR) was submitted on April 22, 1976. Budgetary provisions for ESR are contained in the First and Second Concurrent Budget Resolutions for the fiscal year 1977 budget.

Decisions Facing Congress

The Congress will decide:

- Whether to accept or reject the FEA implementation plans for the strategic petroleum reserve.

The following considerations are relevant to such a determination:

  - How big a reserve is needed?
  - What should be the source of fill?
  - How should the reserve be used, in case of emergency or otherwise?

78-170 O - 76 - 2

- What provision should be made for funding the implementation of the approved plan?

The Size of a Strategic Reserve

Congress has already provided supplemental funding for storage in the fiscal year 1976 budget, for the purpose of constructing crude oil storage facilities in salt domes. In addition the Second Concurrent Resolution on the Budget for the fiscal year 1977 provides funds for the purchase of 40 million barrels of crude oil at $11.00 per barrel. These funds were provided toward creation of 150 million barrels of crude storage required by the early storage reserve plan. EPCA calls for a strategic reserve of at least 495 million barrels and seems to suggest a maximum of 1 billion barrels. In this context, the alternatives open for consideration range from 150 million to 1 billion barrels.

The optimal size for a reserve depends upon three primary factors: vulnerability to an interruption of imports, the cost of obtaining, and the costs of keeping a reserve. These primary factors, in turn, depend on other variables. Vulnerability to an interruption of imports depends upon the level of imports and the likelihood of an interruption. The likelihood of an interruption is primarily a function of international politics and economics.

Since EPCA does not explicitly consider price protecton as an objective, the implications of various price manipulations are not examined. Few analyses of strategic reserves have treated, in depth, the likelihood of an import interruption. The United States has become increasingly dependent upon petroleum imports from the Middle East, Africa, and Indonesia. While such dependence does not provide a direct indication of the likelihood of an interruption, our increased reliance on countries that are culturally and geographically distant cannot be reassuring. It would appear that U.S. foreign policy options vis-a-vis its major oil exporters will be affected for the foreseeable future.

Most analyses of the cost of an interruption start with the assumption of an interruption of a specified size and duration. The size and duration of the interruption determine the resulting losses to Gross National Product (GNP). However, real GNP losses may also be experienced as a result of precipitous increases in the price of imported oil.

If the occurrence of an embargo is assumed to be certain, the larger and longer the embargo, the larger the reserve required to compensate for it. For example, an optimal sized[1] reserve for a 2 million barrel per day interruption lasting 180 days would require 400 million barrels; An optimal-sized reserve for a 4 million barrel per day interruption, lasting 360 days, would require more than 530 million barrels.

Another way to look at the strategic reserve is simply as a means of buying time. Assuming U.S. oil imports in 1985 will reach 10.0 million barrels per day. (as some suggest), a 500 million barrel reserve would give protection against a total interruption for only 50 days. A 2.0 million barrel per day interruption would be completely covered for 250 days.

How Should the Reserve be Filled?

Two major considerations in filling the strategic reserve are the source of crude oil to be used for fill, and the rate at which the reserve will be built up.

Although four sources of crude can be used for storage, two (domestic crude from existing fields and federal royalty oil from off-shore fields) have been ruled out by FEA as inequitable, in that federal use of those sources for storage would force the private sector of the economy to greater use of higher-priced (imported) crude. Of the remaining two sources, imports and production from Naval Petroleum Reserves (NPR), FEA appears to favor imports. FEA's Early Storage Reserve plan is predicated upon almost exclusive use of imported crude. Nevertheless, production from NPRs may be viewed as a competing option.

After production possibilities for NPR crude are determined, and after FEA has identified valid criteria for restricting the types of crude to be stored, two circumstances would warrant the use of NPR crude for storage. These circumstances are delinated in P.L. 94-258 which provides for the sale of NPR production in the domestic market, and states that the receipts can be used to offset strategic reserve costs. The first circumstance

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1. Federal Energy Administration, "Cost Benefit Analysis", May 13, 1976; optimal size is based upon estimates of the costs of storage and the economic costs of an import interruption. The level of storage at which the sum of those costs is minimized is optimal.

exists when the delivered price of NPR crude plus its marginal production costs, is less than the delivered price of imported crude. So far it would appear that NPR crude is being sold in California at average prices approaching $11.50 per barrel.[2] Adding to that price, production and transportation costs of $1.50 per barrel, would mean a delivered price of $13 per barrel on the Gulf Coast. As long as imports are available at $13 per barrel or less, no advantage accrues to the use of NPR crude for storage.

The other circumstance influencing the use of NPR crude exists when all of the potential production from NPRs cannot be sold. In this situation, that portion of NPR production in excess of what must be delivered to the market can be used as fill at costs of production and transportation, assuming that the oil produced satisfies quality requirements. Based upon currently anticipated production capacity and currently anticipated sales, approximately 30,000 barrels per day of NPR crude can be so provided in fiscal year 1977.

The second major consideration in filling the strategic reserve--determining the rate at which the reserve will be built up--will largely be governed by technological requirements associated with preparing salt dome storage facilities. Although EPCA mandates that 10 percent of reserve size should be provided by July 1977, it is unlikely that this goal can be achieved. However, the possibility of achieving the more distant goal, 500 million barrels by fiscal year 1982, appears to be good.

In this analysis, two alternative schedules for filling the reserve are posited. One is derived from technical data on the construction of salt dome facilities contained in a draft report: "Petroleum Storage for National Security" prepared by the National Petroleum Council (NPC) in August of 1975. The other is derived from data presented in the Federal Energy Administration's (FEA) early storage reserve plan. Both schedules provide for 500 million barrels of crude oil storage by September 1982. However, they differ in the yearly rates of accumulation. The NPC derived schedule provides for 175 million barrels of fill in its largest year, fiscal year 1981; while the FEA derived schedule provides for 120 million barrels of fill in its largest year, fiscal year 1978.

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2. The first sale of NPR crude occurred in July of 1976. Approximately 90,000 barrels per day were sold at prices, including bonus payments, of approximately $11.50 per barrel.

Costs and Budget Impacts

The on-budget costs of a 500 million barrel strategic petroleum reserve depend primarily on the costs of crude oil that is to be stored. Imported oil is the most expensive source in budget dollars and NPR oil is the least expensive. However, the use of NPR oil for storage is complicated by the fact that it can also be sold to provide revenues for storage.

Salt domes represent the most economical form of storage facility and can be provided at relatively modest costs of approximately $1.40 per barrel.

For budgetary purposes, five cases are presented. Each case is defined by schedule and source of fuel. One of the two schedules is used; either that derived from NPC data, or that derived from FEA data. One of three sources of fuel is used (NPR, domestic, imported). The resulting calculations indicate that outlays over the six-year period provided for completion of 500 million barrels of crude oil storage could range from 1.8 to 7.3 billion 1975 dollars, depending on which case is implemented. Receipts from NPR sales during this same six-year period are estimated to total from 0.7 to 6.2 billion 1975 dollars, depending on the case used.

The outlays for a 500 million barrel program and NPR receipts are outlined in Table S-1 by case in millions of 1975 dollars. Case V in which total outlays reach $7.3 billion is likely to approximate the FEA plan.

The costs of a 150 million barrel program could range from $1.3 billion to $2.8 billion. A one billion barrel program could range from $8.9 billion to $14.6 billion. Each of these alternate cases assume the schedule associated with case II, and vary depending upon the use of imported or NPR crude.

When and How Should the Reserve be Emptied?

The reserve mandated by EPCA is designed to offset the effects of an embargo. In that context the management of the reserve will involve balancing a complex relationship among conservation programs, diplomatic efforts and

TABLE S-1
OUTLAYS AND RECEIPTS FOR A 500 MILLION BARREL
PETROLEUM STORAGE PROGRAM
(Millions of 1975 Dollars)

	FY 77		FY 78		FY 79		FY 80		FY 81		FY 82		6-yr. Total	
	Outlay	Receipts*	Outlay	Receipts	Outlay	Receipts	Outlay	Receipts	Outlay	Receipts	Outlay	Receipts	Outlay	Receipts
Case I NPC schedule NPR oil	285	230	150	430	150	770	252	290	1,340	—	250	20	2,427	1,740
Case II FEA schedule NPR oil	185	460	635	—	243	140	313	90	327	—	111	30	1,814	720
Case III NPC schedule Domestic oil	593	810	561	1,150	355	1,150	715	1,150	1,441	1,040	866	880	4,531	6,180
Case IV NPC schedule Imported oil	860	810	917	1,150	533	1,150	1,115	1,150	2,375	1,040	1,400	880	7,200	6,180
Case V FEA schedule Imported oil	530	810	1,785	1,150	1,254	1,150	1,371	1,150	1,362	1,040	962	880	7,264	6,180

*Receipts are predicated upon a production schedule implicit in the President's fiscal year 1977 budget. Since the time of the fiscal year 1977 budget submission, The Office of Management and Budget has revised its estimates of fiscal year 1977 NPR sales downward to $475 million.

estimates regarding the duration and intensity of the embargo. The strategy employed in using the reserve will influence its effectiveness, and hence the optimal size of the reserve. There has been little analysis to date of the use strategy. Damage to the economy could result from price manipulation as well as from an embargo; neither EPCA nor FEA's ESR plan take price manipulation into account as a condition which might warrant use of the reserve.

CHAPTER I
INTRODUCTION

The embargo of foreign oil shipments to this country in 1973 and 1974 increased national concern for developing measures to mitigate the effects of potential future interruptions. Instituting such measures is part of the development of an overall national energy policy designed to ensure stability of energy supply at prices consistent with sustained economic growth and other economic, social, and environmental objectives.

In recent years, our economy has become increasingly dependent upon imported petroleum. The economic implications of import dependence were vividly illustrated by the 1973-1974 embargo, in which we experienced cutbacks in production and demand for a variety of products and services that depended heavily on oil. The rise in petroleum prices beginning in 1973 had important consequences for relative costs throughout the U.S. economy.

Creation of reserves of petroleum is an obvious alternative that could provide a measure of protection against the effects of future embargoes. The idea of maintaining usable reserves, whether called "storage" or "stockpiles,"[1] was proposed in the energy policy initiatives of both the Congress and the President during 1975. The version originating in the Congress was enacted into law in December 1975, as part of the Energy Policy and Conservation Act (EPCA).

What Is a Strategic Petroleum Reserve?

A strategic petroleum reserve consists of crude oil or refined petroleum products that have been drawn from natural reservoirs and placed in storage facilities, from which they can be removed at a rapid rate when needed. These facilities may be above-ground steel tanks, underground cavities created in salt domes, or mined caverns in suitable rock formations. These installations must be fitted with pumping, pipeline, and tanker loading facilities to provide for filling and for extraction and transport to refineries or distribution points where the fuel may be needed.

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1. Hereafter, the term "storage" will be used.

78-173 O - 76 - 3

A strategic petroleum reserve of this type is not the same as the "Naval Petroleum Reserves". The four existing U.S. Naval Petroleum Reserves (NPRs) are tracts of federally-owned land known to contain crude oil deposits. They had been placed in reserve by act of Congress, intended originally for military use. A number of wells have already been drilled on those tracts, to enable crude oil to be pumped when needed. The critical difference between such natural crude oil deposits and crude oil held in storage facilities is the rate of extraction. Oil in storage facilities can be pumped out much more swiftly than oil in natural formations. The maximum efficient rate of production from Naval Petroleum Reserve #1 (NPR 1) at Elk Hills, California, the only naval petroleum reserve that is currently extensively developed, has been estimated at 267,000 barrels per day.[2] Even if pipeline capacity were adequate to ensure delivery of that amount, it would fall far short of the quantities which could be required in the event of a serious interruption of imports.[3]

Why Is a Strategic Petroleum Reserve Needed?

Protection against import vulnerability

The stated objective of storing a reserve of petroleum is to mitigate the effects of possible future supply interruptions. Specifically, EPCA seeks to diminish U.S. vulnerability to a severe but relatively brief interruption of the flow of imported petroleum. U.S. imports of crude oil and refined petroleum products averaged 6.0 million barrels per day in 1975. In March of 1976 net U.S. imports of crude oil products averaged 7.1 million barrels per day.[4]

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2. Source: National Petroleum Council, Petroleum Storage for National Security. Estimates of the maximum efficient rate of production vary depending upon the scheduling of production. FEA is currently using 212,000 barrels per day.

3. For a discussion of the optimal size of a reserve, see Chapter II.

4. Source: Office of Economic Research, Central Intelligence Agency, "International Oil Development, Statistical Survey," July 1, 1976. Crude data for the U.S. does not reflect Guam, Virgin Islands, and Puerto Rico.

A reserve inventory would enable the United States to offset either a domestic or foreign interruption. The size of the reserve will obviously dictate how long and how big an interruption could be avoided.

Other uses of a strategic reserve

In addition to diminishing effects of supply interruptions, a petroleum reserve could have other uses, particularly in connection with pricing policy. Reserves could even out fluctuations of prices in commodity markets. They could be employed to depress prices in an inflationary situation, or conversely, (by withholding current production for the purpose of building reserves) could be used to raise prices. (See discussion in Appendix A, "Other Uses of Strategic Reserves").

Energy Policy and Conservation Act

EPCA mandates creation of a strategic petroleum reserve in two stages: an early storage plan of a minimum of 150 million barrels to be placed in reserve within three years of enactment (i.e., by December 1978), and a second stage of at least 345 million barrels--making a minimum total of 495 million barrels—to be stored within seven years of enactment (i.e., by December 1982).[5] The maximum total storage would be one billion barrels. EPCA requires the Administrator of FEA to develop and submit to Congress implementation plans for the early storage program plan within 90 days of enactment, and the full plan by December 1976. The early storage plan was in fact submitted April 22, 1976. EPCA also allows for industry to participate in the storage program under what it calls "industrial storage." On top of that provisions exist to ensure availability of fuel to the various regions of the country, under EPCA "regional storage."

Issues and Options

A number of questions remain to be decided by the Congress in approving FEA's implementation plans and in providing funds for execution of those plans:

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5. The derivation of the second-stage minimum is presented in Chapter II.

How big should the final reserve be? Options include:

- 500 million barrels (FEA target)
- one million barrels (upper limit)

What source of crude should be used to fill it? Options include:

- NPR #1, 2, & 3
- Domestic Fields
- Imports
- Royalty oil from leased federal lands

How rapidly should the reserve be filled? Constrained by:

- Funding, or production from NPRs
- Construction of facilities

What kind of storage facilities should be used? Options include:

- Steel tanks
- Salt domes
- Mined caverns

How should use of the resources be regulated? Options include:

- Legislative controls[6]
- Executive discretion without legislative restraint

What are the likely costs of various programs? Components of cost are:

- Facility costs
- Cost of fuels

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6. Price conditions as a trigger for employing the reserve are not explicitly considered in EPCA.

How should they be financed? Options included:

-- Industrial participation via regulation
— Federal receipts from NPR sales
-- Direct funding on-budget

What would be the likely budgetary impact of the various options?

These issues are addressed in succeeding chapters.

CHAPTER II
HOW *BIG* SHOULD THE RESERVE BE?

A strategic petroleum reserve is, in a sense, an insurance policy against the potential effects of an interruption in supplies of petroleum. The decision on the required size of the reserve, then, is like the decision on the size of an insurance policy. One must balance the cost of insurance against the likelihood and severity of the threat insured against. It is possible to buy too much insurance, or too little.

The likelihood of an import interruption of a given size and duration has not been addressed very thoroughly in the analyses supporting the creation of a strategic petroleum reserve. Most such analyses assume an interruption of a given level for the purpose of determining the size of the reserve. They do not, however, address the likelihood of an embargo.[1] While some observations relevant to the likelihood and magnitude of an interruption may be offered, no definitive analysis of the appropriate size of a reserve has been developed. Nor has there been any examination of the potential frequency of interruptions. If at least one embargo is considered to be likely, the possibility of additional subsequent embargoes should be considered. The relevance of questions relating to the pattern or frequency of anticipated embargoes is apparent if one recognizes that stored petroleum, once used, cannot be used again. Oil from the strategic reserve that is used to mitigate the effects of one interruption will not be available to cope with the effects of a second interruption, shortly thereafter.

Previous Levels and Composition of Imports

The 1973-1974 embargo was instituted by the Organization of Arab Petroleum Exporting Countries (OAPEC), not by the larger Organization of Petroleum Exporting Countries (OPEC). However, non-Arab OPEC countries did participate in price agreements which brought about dramatic increases in world oil prices. U.S. imports of crude oil from OAPEC in

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1. For example: Examine the National Petroleum Council study, "Petroleum Storage for National Security," August 1975, or the FEA, "Early Storage Reserve Plan," April 1976.

September 1973, averaged 1.07 million barrels per day, or less than 31 percent of U.S. crude imports in that month, which totalled 3.47 million barrels per day. During the first quarter of 1974, U.S. OAPEC imports averaged .06 million barrels per day. Three non-Arab OPEC countries (Gabon, Iran, and Nigeria) actually increased their exports to the United States during the first quarter of 1974. Other major exporters to the United States, with the exception of Venezuela, registered only slight decreases from September 1973 levels.

By January 1976, post-embargo OAPEC crude exports to the U.S. had risen to 2.038 million barrels per day or 44 percent of total U.S. crude imports. This substantial increase in dependency on OAPEC crude is attributable in part to a dramatic decrease in U.S. imports from Canada and Venezuela, from 41.5 percent of U.S. crude imports in September 1973 to only 12.1 percent of U.S. imports in January 1976. (See Table 1 on next page.)

Total U.S. imports of crude oil in January 1976 have increased by roughly one million barrels per day since September 1973, or approximately equivalent to the increase in OAPEC exports to the U.S.

If OAPEC is viewed as the least secure source of imported oil, it is clear that the United States has become increasingly dependent upon what it considers to be its least secure source of imports.

The geographic and cultural distances that separate exporting countries and their interests from our own suggest the possible circumstances that could lead to termination of oil exports. The most significant single country source of non-Arab OPEC crude imports is Nigeria, whose exports to the United States are second only to those of Saudi Arabia.

Significant U.S. reliance on OPEC countries for crude (84 percent of imports in January 1976), will tend to constrain U.S. foreign policy options vis-a-vis the major OPEC producers.

TABLE 1
SELECTED DEVELOPED COUNTRIES: UNITED STATES CRUDE OIL IMPORTS, BY SOURCE

Thousand b/d

	Sep 1973 (Pre-Crisis Level)	1974				1975				1976	Percent of Total	
		1st Qtr	2d Qtr	3d Qtr	4th Qtr	1st Qtr	2d Qtr	3d Qtr	4th Qtr	Jan	Sep 1973	Jan 1976
Algeria	124	4	232	249	232	255	293	276	233	332	3.6	7.2
Egypt	—	—	17	12	6	—	—	6	12	31	—	0.7
Iraq	17	—	—	—	—	—	2	5	—	—	0.5	—
Kuwait	44	—	2	12	5	6	9	1	1	—	1.3	—
Libya	153	7	4	—	—	92	166	357	273	433	4.4	9.4
Qatar	41	—	4	23	41	28	2	30	13	13	1.2	0.3
Saudi Arabia	599	45	418	551	728	752	405	672	975	1,110	17.3	24.2
United Arab Emirates	88	3	86	145	40	88	91	194	92	119	4.5	2.6
Total OAPEC	1,066	59	763	992	1,052	1,221	,,968	1,541	1,599	2,038	30.7	44.4
Gabon	—	—	19	35	39	40	32	23	13	18		0.4
Ecuador	33	55	65	18	29	47	57	62	62	50	0.9	1.1
Indonesia	249	247	293	284	309	291	372	453	396	478	7.2	10.4
Iran	205	394	574	492	390	287	277	232	319	386	5.9	8.4
Nigeria	409	458	708	829	787	828	620	764	766	773	11.8	16.8
Venezuela	405	253	255	387	378	316	461	439	363	133	11.7	2.9
Total OPEC	2,367	1,466	2,660	3,025	2,978	3,030	2,787	3,508	3,506	3.845	68.2	83.7
Canada	998	837	837	737	754	611	498	644	647	423	29.8	9.2
Other	106	65	188	164	138	196	303	329	331	295	3.0	6.4
Total	3,471	2,368	3,702	3,938	3,876	3,837	3,588	4,487	4,496	4,594	100.0	100.0

*SOURCE: Office of Economic Research, Central Intelligence Agency, "International Oil Developments, Statistical Survey," July 1, 1976.

Criteria for Decision

Difficulties in determining the size of a reserve arise because the reserve is to be created and paid for now, in order to guard against interruptions which may or may not occur at some unknown dates in the future, and which will be of unknown extent, duration, and frequency. The costs of the reserve will depend on the anticipated likelihood, date, extent, duration, and frequency of interruption. The effectiveness of the reserve will depend on the way that the reserves actually prevent interruption of supplies. While it is not possible to perform the calculations precisely, it is possible to discuss some criteria by which to select alternatives.

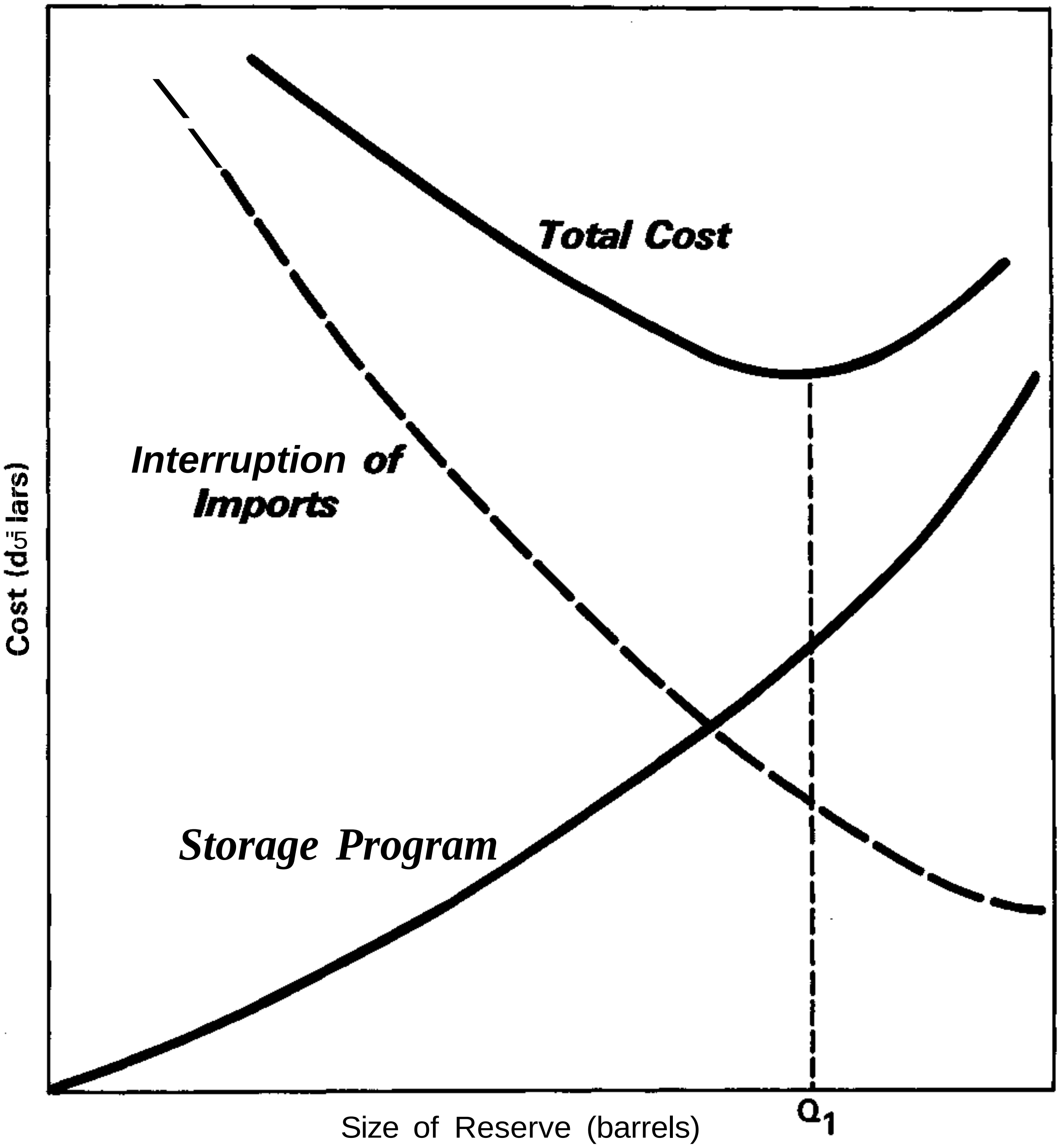
In principle, it should be possible to calculate the anticipated costs to the economy of a future interruption of imports by use of a common date and a specific size of a reserve, and to compare those costs with those of a reserve (Figure 1).

Suppose that one knew with certainty that some 30 percent of imported petroleum would suddenly be embargoed on July 1, 1980, and that the embargo would last for 45 days. For some assumed total level of imports, one could then theoretically calculate the cost to the economy of the interruption. If we had a very large reserve, only minor inconveniences might result, with very small costs. As the gap between demand and the available supply (plus reserve drawdown) increases, the costs of a lost barrel of oil increase. Furthermore, as the supply of oil is increasingly insufficient to sustain essential economic activity, loss of productivity and unemployment may be experienced. The costs of a possible import interruption are relatively greater with a smaller reserve (or greater import dependence).

On the other hand, the larger the reserve, the more it costs, as less expensive storage facilities and petroleum supplies are used to their maximum and more expensive ones must be purchased. The optimal reserve size, in terms of total cost, is that which minimizes the sum of the cost of the reserve and the cost of interruptions. That size is reached when the cost of putting one more barrel of oil in the reserve equals the reduction in the cost of interruption that results from the availability of one more barrel of oil (see Figure 1).

Figure 1.

COSTS OF STORAGE AND OF SUPPLY INTERRUPTION (Example)



Difficulties arise because none of the parts of this calculation are certain; indeed, they will vary widely with the date on which the interruption is expected to occur, and on several external factors and policy choices, including the following:

- Future energy demand is uncertain, and depends, among other things, on the health of the economy, on world oil prices, on domestic energy pricing policy, and on the extent of energy conservation measures.

- Future domestic energy supply is also uncertain; and depends on factors such as energy prices, possible government incentives to energy production and development,[2] and the fortunes of technology and geology. Thus future import levels, which represent the difference between demand and domestic supply, are also highly uncertain.

- The distribution of U.S. imports among oil exporting countries--and hence the extent of potential interruption--depends both on the total level of U.S. imports and on the policies of the oil exporting countries toward development of their resources.

- The likelihood, duration, and frequency of any interruption depend on several political factors including, possibly, the size of the reserve itself.

- Finally, the extent of the interruption to be coped with depends on several domestic considerations, such as consumer attitudes towards conservation, hoarding, and the availability of alternative emergency measures.

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2. See, for example, Financing Energy Development: Congressional Budget Office, Background Paper No. 12, July 26, 1976. Such incentives may be designed for the same general energy policy objectives as underlie the storage program.

Thus, the optimal reserve size is unlikely to *be* static, but is likely to change with time and to be a function, of policy decisions in other areas and of external factors such as the success of exploration or of the development of technologies, not yet proven, for exploiting hitherto untapped resources. A scenario of possible outcomes is depicted in Figure 2.

In principle, it should be possible to assign probabilities and values to those outcomes, and to determine such an optimal level of reserves over time. Such models are not yet available to assess overall interactions, nor have the basic uncertainties been resolved. Thus all analyses to date have adopted simpler approaches, selecting (typically) a single year for analysis, and neglecting the irregular and uncertain character of costs of interruption.

Costs of an Embargo

A number of studies have attempted to estimate the economic costs which will be associated with a future interruption of imports. FEA estimated the economic impact of an interruption in 1985 under various assumptions regarding implementation of its 1975 plan. A one-year interruption at 3.0 million barrels per day would cause a GNP loss ranging from $186.1 billion (1975 dollars) if none of the measures were enacted to $32.9 billion if all measures (except proposals relating to the Clean Air Act) were enacted. A similar study by the Center for Naval Analysis (CNA), conducted in November, 1974, concluded that a one-year embargo similar to that in 1973-1974 (i.e., a partial rather than total interruption) would cost between $49 and $117 billion (1973 dollars), equivalent to a 7.2 percent reduction in GNP.[3] The CNA study also estimated that the GNP loss from a (less likely) complete interruption of all imports for one year might be 41.8 percent of projected GNP, or $795 billion.

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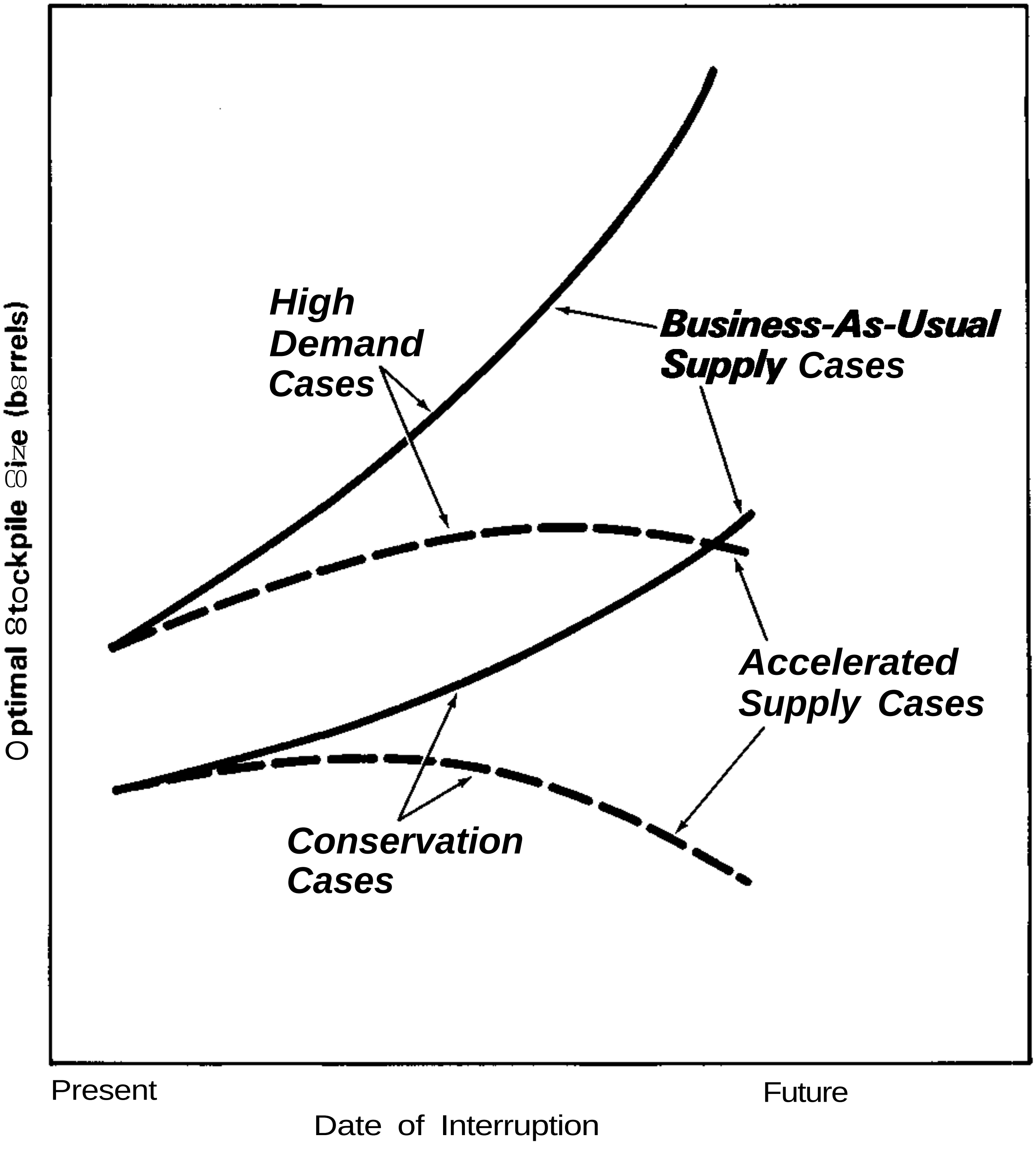
3. Randall G. Holcombe, "The Economic Impact of an Interruption on United States Petroleum Imports: 1975-2000", Center for Naval Analysis, November 1974.

Figure 2.

OPTIMAL STOCKPILE AS FUNCTION OF DEMAND AND SUPPLY (Example)



Currently FEA is basing its "cost-benefit analysis" on the loss-estimating relationships used in the CNA study. However, the current FEA analysis calculates GNP losses on the basis of an interruption of 2.0 million barrel per day and 4.0 million barrel per day, instead of 3.0 million barrels per day assumed by CNA. The duration of the interruption in each case is 180 and 360 days, respectively. FEA's study shows that the stockpile is effective in mitigating GNP losses in the instances examined (See Table 2).

This particular FEA analysis posits storage costs on the basis of an average present value calculation, which includes capital costs, operating costs and a 10 percent "opportunity cost for capital"[4] between 1976 and 1990. The results of the calculation for a 2 million barrel per day interruption for 360 days, shows the costs of 155, 430, and 530 million barrel reserves as 1.9, 3.8 and 4.2 billion 1975 dollars, respectively. Using this cost data and the GNP loss data, the FEA study estimated the optimal size of strategic storage on the basis of maximizing average present value net savings at the smallest possible storage cost. The results, for a certain interruption of a given size and duration are:

Interruption	Optimum Size of Stockpile
4MMB - 360 days	Greater than 530 million barrels
4MMB - 180 days	530 million barrels
2MMB - 360 days	500 million barrels
2MMB - 180 days	400 million barrels

Guidelines in the Energy Policy and Conservation Act

Lacking comprehensive analyses but persuaded of the urgency of beginning a storage program of some size, the architects of the Energy Policy and Conservation Act established a minimum "early storage" program designed to initiate the process of creating a reserve, and ordered FEA to study and recommend a follow-on program.

4. Opportunity costs are calculated to account for the need to forgo capital investment in other activities in order to finance storage.

TABLE 2

Average GNP Losses Due to an Embargo
(Average present value, 1976-1990 in billions of 1975 dollars)

2.0 million barrel per day interruption						
	180 day interruption			360 day interruption		
Stockpile Size	155MMB[1]	430MMB	530MMB	155MMB	430MMB	530MMB
GNP Loss w/o Stockpile	11.1	11.1	11.1	22.3	22.3	22.3
GNP Loss w/Stockpile	6.6	4.0	4.0	16.8	11.3	10.3

4.0 million barrel per day interruption						
	180 day interruption			360 day interruption		
Stockpile Size	155MMB	430MMB	530MMB	155MMB	430MMB	530MMB
GNP Loss w/o Stockpile	51.0	51.0	51.0	102.1	102.1	102.1
GNP Loss w/Stockpile	26.5	16.7	15.5	68.3	50.1	47.3

1. Million Barrels

SOURCE: FEA, Strategic Petroleum Reserve Office, Cost Benefit Analysis, May 1976.

EPCA provides (in Section 151) for a maximum of up to one billion barrels, but not less than 150 million barrels by December 1978. The minimum level of 150 million barrels is likely to be below an optimal long-term level.

The implementation provisions (Section 154) further specify that the reserve should ultimately contain a quantity of stored crude oil equal to the total volume of crude oil imported into the United States[5] during three consecutive months of the 24-month period preceding December 1975, when the average monthly import levels were the highest. The highest consecutive three-month average occurred August, September, and October of 1975, when daily crude oil imports averaged, respectively, 5.6 million barrels per day, 5.2 million barrels per day and 5.4 million barrels per day.[6] Averaging these numbers gives a mandated minimum storage quantity of 495.3 million barrels (hereafter we will consider this amount to be 500 million barrels).

The Anticipated Level of Future Imports

As was noted earlier, most of the discussion to date has focused on projecting the level of imports in the years to come rather than the likelihood of interruptions. It should be understood that future import levels depend upon all of the policies and physical factors that effect production and consumption decisions. To the extent that those policies are in flux, and that there are significant technical uncertainties, it is not possible to project imports with precision. Strategic storage presumes import dependency. Both FEA's 1975 energy proposal and EPCA aim at some reduction in import dependency. Among recently enacted initiatives potentially affecting import dependency are EPCA (incentives for mining and use of coal and to develop advanced automotive technology, conservation programs, and standby rationing authority), P.L. 94-258 (authorizing production from NPRs), and ERDA authorizations (affecting research on both conservation and new energy supplies).

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5. FEA counts imports to Puerto Rico, Virgin Islands and Guam in the United States totals for this purpose.

6. Federal Energy Administration, Early Storage Reserve Plan, April 22, 1976.

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Estimates of future U.S. dependency on imports of crude oil vary, depending upon the projected energy policy scenarios and on other considerations. FEA has estimated imports of crude oil and petroleum products will range between 7.0 and 14.3 million barrels per day in 1985.[7] The National Petroleum Council (NPC) has estimated 1985 imports ranging from a low 5.4 million barrels per day to a high of 12.5 million barrels per day.[8]

Size of an Import Interruption

Neither FEA nor NPC assume complete interruption of imports as a basis for calculating the required storage. NPC estimates a reduction on the order of 3.0 million barrel per day. The FEA analysis assumes that a moderate interruption would approximate 2.0 million barrels per day, while an interruption of 4.0 million barrels per day would be very large.[9] The NPC calculations presumed a 2.5 million barrels per day interruption for five months, similar to estimates of the OAPEC embargo.

Alternatives for Coping with an Embargo

Once an interruption occurs, measures other than startegic reserves could be used to counteract its effects.

EPCA calls for the creation of emergency conservation and rationing contingency plans. The conservation plan would impose reasonable restrictions on public or private use of

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7. Federal Energy Administration, Draft Environmental Impact Statement, DES 76-2, June 1976. For a more detailed discussion of import projections and energy policy scenarios, see FEA's, Draft Environmental Impact Statement, DES 75-2, March 1975.

8. National Petroleum Council, "Petroleum Storage for National Security," August 1975. The National Petroleum Council is an Industry Advisory Council to the Secretary of the Interior.

9. FEA, Office of Strategic Petroleum Storage, Cost Benefit Analysis, May 1976.

energy. While some of these restrictions might border on a form of rationing or allocation, several might not directly affect the freedom of consumers to purchase energy in whatever amounts they desire, at the prevailing price. Similar measures were attempted during the last embargo, e.g., lowering speed limits, changing business hours and reducing heating and cooling in public buildings. These measures could be used during an interruption of imports which might be expected to last for a limited period of time. In a 1975 plan, FEA requested authority from Congress to impose rationing and other conservation measures as part of a standby authority. If this authority were invoked, FEA estimated that potential savings would be 1.7 million barrels a day in 1985.10 Accordingly the FEA/NPC 1985 import estimates of 8.5 to 12.7 million barrels per day could be reduced to a range of 6.8 to 11.0 million barrels per day. Alternatively, if the interruption were on the order of 2.0 to 4.0 million barrels per day, emergency measures could reduce consumption so that a shortfall of only 0.3 to 2.3 million barrels per day would be required from the reserve.

Duration of Protection From Reserves

The duration of protection provided by the various sized reserves is depicted in Figure 3 for several levels of interruption. If import levels are about 10 million barrels per day by 1985, the 500 million barrels storage currently required by EPCA would provide protection from a total interruption for 50 days. The maximum one billion barrel storage would provide protection against a total interruption for 100 days. These calculations do not take into account emergency conservation measures or the possibility that not all imports would be cut off.

Although the length of the period of complete protection depicted in Figure 3 may be a rather simplistic way to look at the matter, it does help to set degrees of insurance associated with various sized stockpiles. Realistically, the United States is probably not going to be subjected to a total embargo of imports (Figure 4

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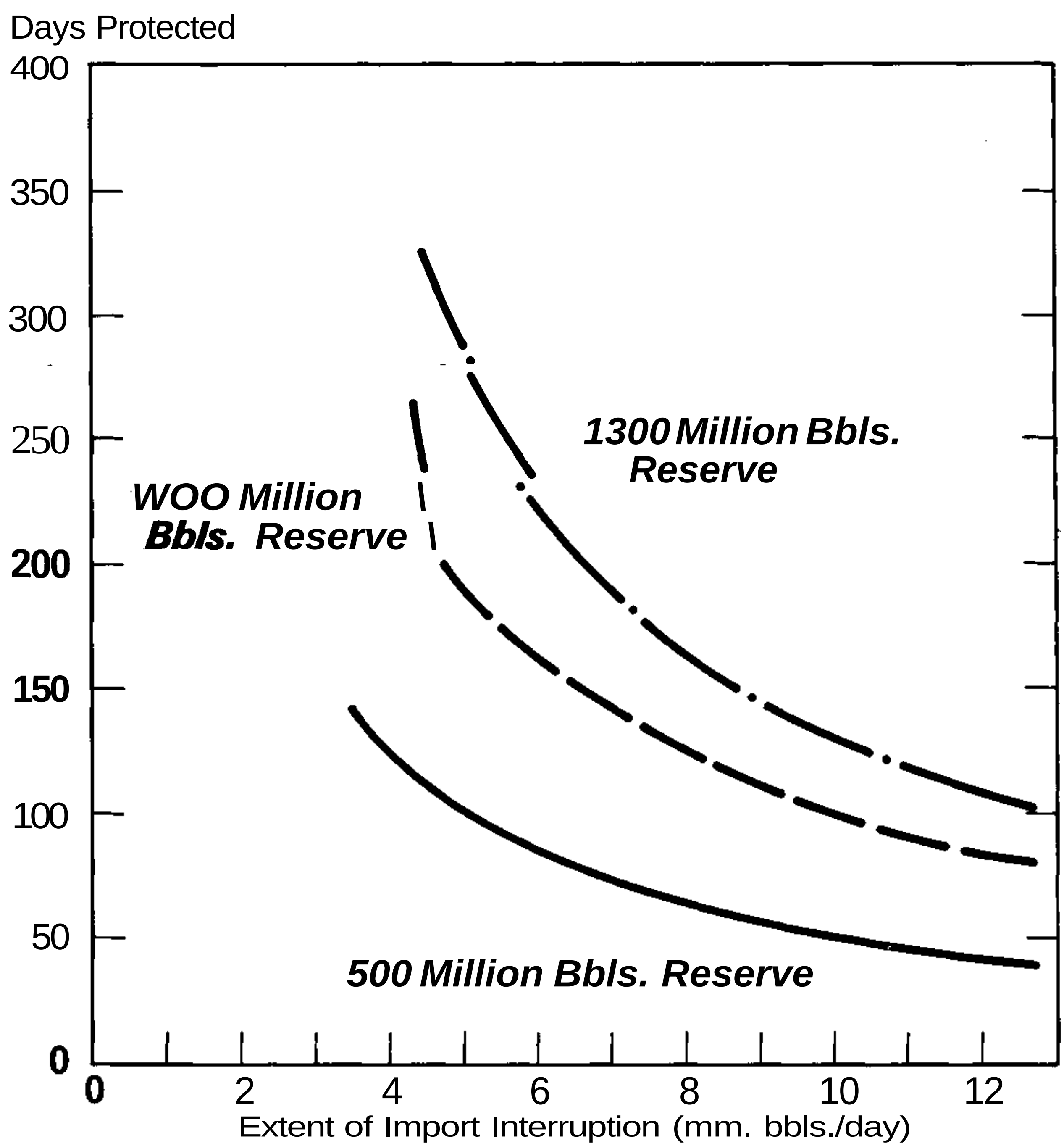
10. FEA, DES 75-2, pg. 4-21.

Figure 3.

DURATION OF PROTECTION AS A FUNCTION OF EXTENT OF INTERRUPTION AND SIZE OF RESERVE



illustrates impact of various levels of embargo effectiveness) nor would the United States necessarily draw down its reserves at a uniform daily rate during the course of an embargo. If an embargo reduced imports by 2.0 to 4.0 million barrels per day, which FEA assumes, the 500 million barrel stockpile would give us total coverage for 250 and 125 days, respectively.

Conclusions

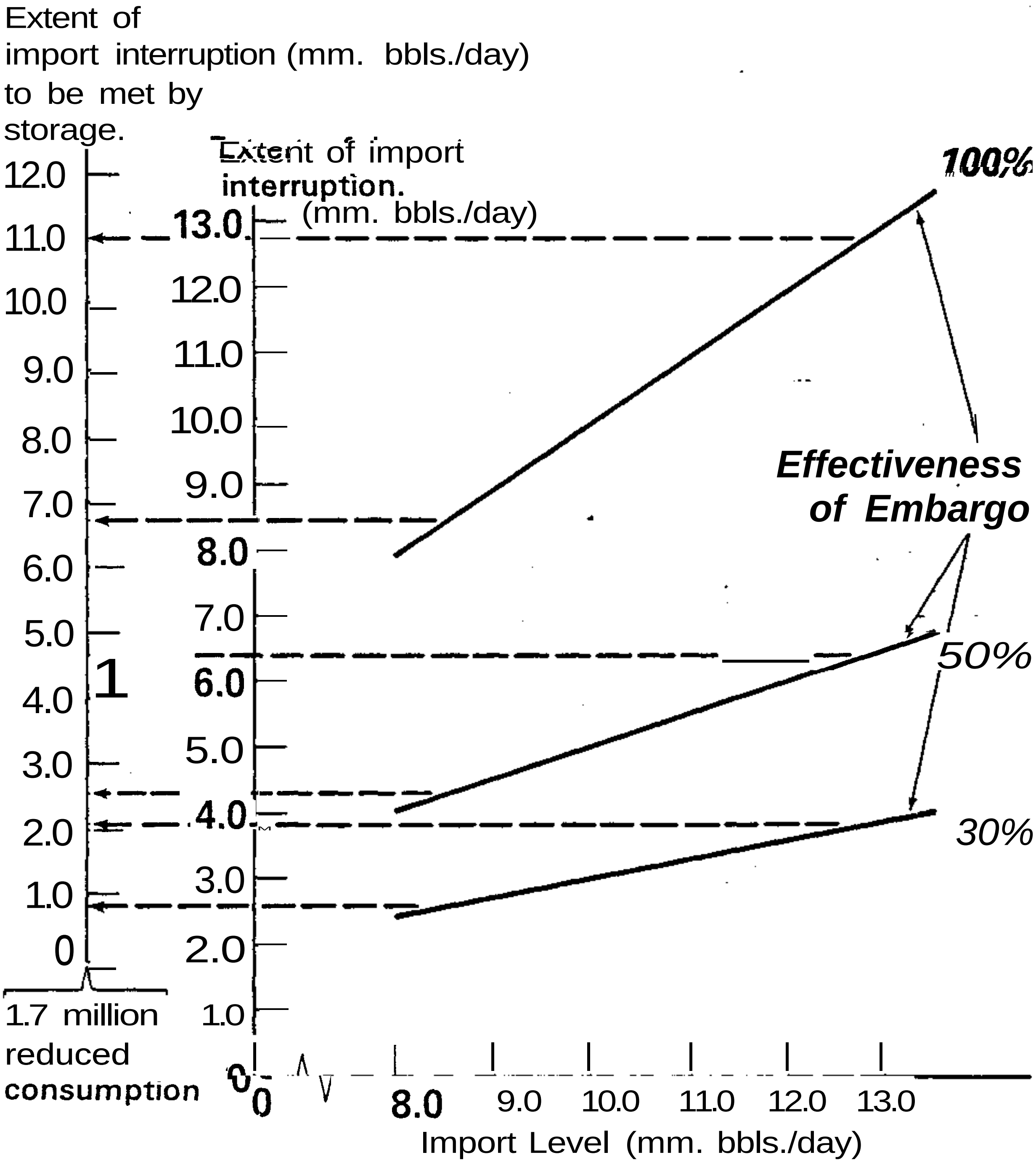
- The size of a required stockpile depends on both the level of imports and the likelihood of an interruption, and is likely to change over time. Most studies assume an interruption of 2.0 to 4.0 million barrels per day.

- The period of protection from a total embargo afforded by a reserve drops dramatically if imports reach levels projected for 1985. For example, if imports reach 10 million barrels per day, the minimum reserve of 500 million barrels mandated by EPCA would give protection from a total interruption for only 50 days. A 2.0 to 4.0 million barrel per day interruption would be avoided for 250 and 125 days, respectively.

- On the basis of anticipated GNP losses and average storage costs, it is clear that longer and more severe interruptions warrant the creation and maintenance of larger reserves. FEA has calculated the optimal size of a reserve to be at least 400 million barrels for the range of alternatives it considered.

Figure 4.

EXTENT OF INTERRUPTION AS FUNCTION OF IMPORT LEVEL AND EFFECTIVENESS OF EMBARGO



CHAPTER III
HOW SHOULD THE RESERVE BE FILLED?

The way in which the reserve should be filled depends on the answers to the following two questions: from what source should the fuel for storage be obtained and how rapidly should the reserve be created?

Source of Fill

There are four alternative sources of fill for a government storage program:

1. Purchase of foreign crude at prevailing import prices.

2. Purchase of domestically-produced fuel from private producers.

3. Use of federal royalty oil received as a condition of lease of offshore drilling rights.

4. Use of petroleum produced from federally owned Naval Petroleum Reserves.

The choice of source of fill depends on two factors: impact on the budget and impact on the cost of oil to other consumers. Oil is currently sold at three different average prices: "old"[1] oil produced domestically sells at $5.15 per barrel, "new" oil produced domestically at $11.60 per barrel, and imported oil at $13.00 per barrel. If the government purchased imported oil, it would pay the prevailing world price.

The purchase of domestically produced fuel from existing sources would directly deplete the current available supply of crude; the presently stored amounts would have to be replaced by imported crude. The effects on the national economy of this option would be equivalent to those resulting from the purchase of imports. However, out-of-pocket budget expenditures would be lower: depending on whether it purchased old or new oil, the government could pay between $5.15 and $11.60 per barrel.

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1. Old oil comes from wells in operation during 1972. New oil comes from wells that were struck after that or from increased production from older wells.

The use of federal royalty crude is limited by the amount available, which is now about 80 million barrels per year. Because of the method of determining royalties, prices for this crude would depend upon the price regulations in effect during the year prior to the year in which the crude is obtained. Thus, the price of crude purchased for storage in 1976 would depend upon domestic price regulations in effect during 1975, when crude could have been sold at between $5.25 and $12 per barrel. The economic effect of using federal royalty crude—which is currently sold in the market-place--would be similar to that resulting from use of imports or domestically produced oil, in that its use would have to be offset by increased imports.

For reasons of equity, FEA planners have ruled out both the use of domestic production under regulated "old oil prices", and the use of royalty oil. The rationale suggested is that extensive government use of cheaper oil sources, available as a result of existing price regulations, would force the private sector to greater use of higher priced oil and thereby defeat the object of price regulations.

There are presently three NPRs in production, NPR #1 at Elk Hills, California, NPR #2 at Buena Vista, California, and NPR #3 at Teapot Dome, Wyoming. Oil produced from NPRs can be obtained at the incremental cost of production--currently some $.30 to $.50 a barrel--and either exchanged for oil near the storage facilities or transported to those facilities for an additional $1.15 to $1.35 a barrel. Since such oil could otherwise be sold at the prevailing domestic market price, the use of NPR production for storage would diminish possible revenues. NPR production might be sold for as much as $13.00 per barrel in the world market.

In choosing among different sources of crude, the government might minimize the budgetary impact of oil storage. However, imports would increase by the amount of oil purchased for storage no matter what the source of fill.[2] Moreover, if the government purchased low priced

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2. As noted earlier, the choice of the least-cost oil for storage would mean that other users would have to pay the higher prices of imported oil; to the extent that they resist such prices, imports (and total consumption) might be slightly less than the amount stored; given the demand elasticities for oil in the short run, this effect is likely to be small.

oil (or utilized low priced royalty or NPR oil), other oil consumers would have to turn to higher priced oil. Consequently, any savings achieved by the government would result in increased costs to other oil onsumers.

The problem of deciding whether to use NPR oil directly for storage is affected by the fact that present law allows for the sale of NPR oil at the highest possible prices determined at auction. The first sale, held in early July of this year, resulted in the sale of 89,800 barrels per day for fiscal year 1977 at an average price of $11.50 per barrel. The Office of Naval Petroleum Reserve offered 132,000 per day barrels for sale, based on the production capacity expected by September of 1976. The federal government was not a bidder in those sales. Whether or not the federal government should have been a bidder depends on a number of factors.

The government should be willing to bid for NPR oil as long as its delivered price is lower than what could be obtained from imports. The average NPR sale price of $11.50 per barrel plus $1.50 production and transportation costs results in an NPR delivered price of $13.00 per barrel on the Gulf Coast. If imports are at a delivered price of $13.00 on the Gulf Coast, as we now assume, the government should be indifferent with regards to the use of NPR oil or imports. However, it should be noted in the present situation, that although NPR oil was sold at an average price of $11.50 including bonuses in July, some of it went for as little as $10.90. Furthermore, 89,800 barrels per day does not represent maximum production from the NPRs in fiscal year 1977. Estimates are that production capacity will reach 120,000 barrels per day by November. Plans to offer a second auction for the remaining 30,000 barrels per day are not counted to be successful because the bulk of that oil is "shallow zone oil"[3] which is surplus in California.[4]

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3. Shallow zone oil at NPR 1 has an average sulfur weight of .83 percent which is nearly twice as high as the Stevens Zone crude (0.48 percent), which constitutes the bulk of the 89,800 barrels sale.

4. Source: Office of Naval Petroleum Reserves.

If the 30,000 barrels per day of excess capacity were diverted to the storage program during fiscal year 1977, it would total 11.9 million barrels, or nearly one-third of what FEA is likely to store during fiscal year 1977. Since that shallow zone oil is not likely to be sold in this year, the government might consider appropriating it for storage at lifting costs. If it were so appropriated, it would offset the purchase of a like amount of imported oil. The savings per barrel would be $13.00 less $1.50 or $11.50 per barrel, for a total of $126 million. Unlike bidding NPR oil away from domestic consumers, use of surplus NPR oil could result in savings which are real as well as budgetary, since no domestic consumer would be forced to buy imported oil instead, at least in the short run.

FEA planners have raised some questions concerning the specific gravity and sulfur content of oil that is to be stored. They would like to store an oil type that can be used by the majority of refiners to produce the current mix of products. They have not as yet firmly decided on the characteristics which will be needed. However, the early storage reserve plan calls for a wide range of oil types. It is conceivable that the range might encompass some quantities of NPR oil.

Rate of Fill

What is the Desired Rate of Fill?

Choosing a rate of fill involves many considerations that affect the choice of the optimal size of a stockpile. How quickly the stockpile should be filled clearly depends on the urgency with which embargo protection is needed. If no embargo is anticipated for some years, formation of the stockpile could be delayed thereby spreading the costs over several years. Such delay would also decrease imputed interest charges on the value of the stockpile. Changing the rate of fill could also change the total budget costs of the stockpile as well. If royalty oil or oil from NPR #1 were less costly than other oil, costs would be reduced by keeping the rate of fill at or below the rate at which supplies could be delivered from those sources. On the other hand, rapid filling of the stockpile could be preferred if oil prices were expected to increase, at a rate greater than the rate of interest.

What are Restrictions on the Rate of Fill?

The rate of fill is restricted by how rapidly storage facilities and oil can be made available, and by the rate of funding.

It may be possible to use existing salt domes[5] for the first increment of storage, so that the only delay would result from conversion to the present purpose. On the other hand, a decision to employ steel tanks for storage would be restricted by steel supply and construction, therefore the buildup would be much slower. The National Petroleum Council (NPC) has put together two possible schedules of salt dome development, which are shown in Figure 5. If crude from NPRs is used as a source of fill or as a source of funding, the rate of fill would be further limited by the maximum efficient rate of production from Elk Hills (Figure 6).

The NPC schedules for constructing salt dome storage facilities presume that salt domes must be leached and outfitted from scratch. The NPC presented a "normal development" schedule which achieves 500 million barrels of salt dome capacity within 66 months. The NPC also presented an "accelerated development" schedule which achieved 500 million barrels within 50 to 54 months.

The Federal Energy Administration (FEA) has put together a slightly different schedule for completing salt dome facilities in its early storage reserve (ESR) plan.[6] In this plan, FEA assumed that salt domes could be obtained which had already been constructed for other purposes. However, the effect of using existing salt domes on the NPC schedule cannot be determined with precision from the ESR plan. In determining an appropriate construction schedule

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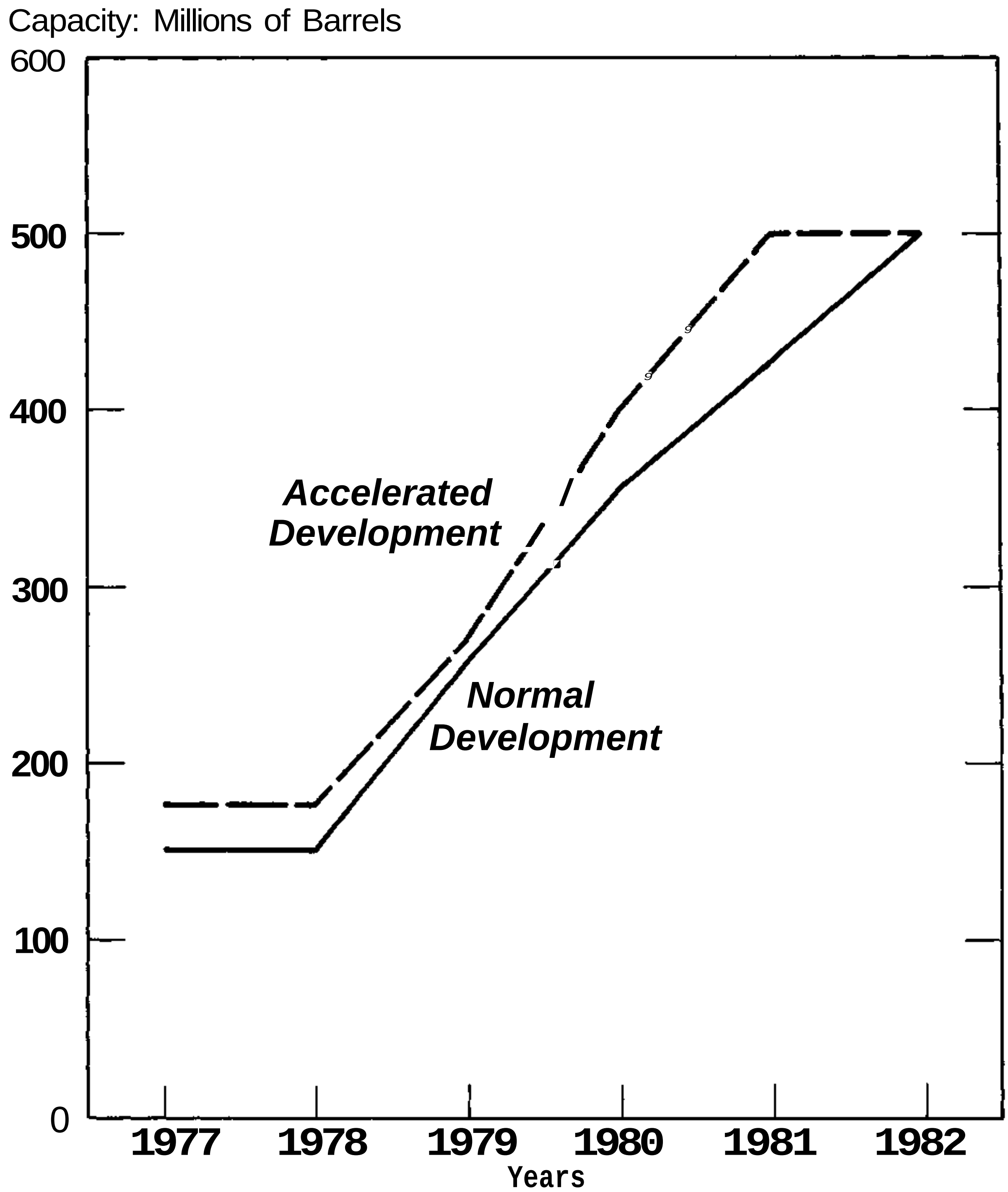
5. See Chapter V for a detailed description of Salt Domes.

6. Federal Energy Administration, "Early Storage Reserve Plan," April 22, 1976.

Figure 5.

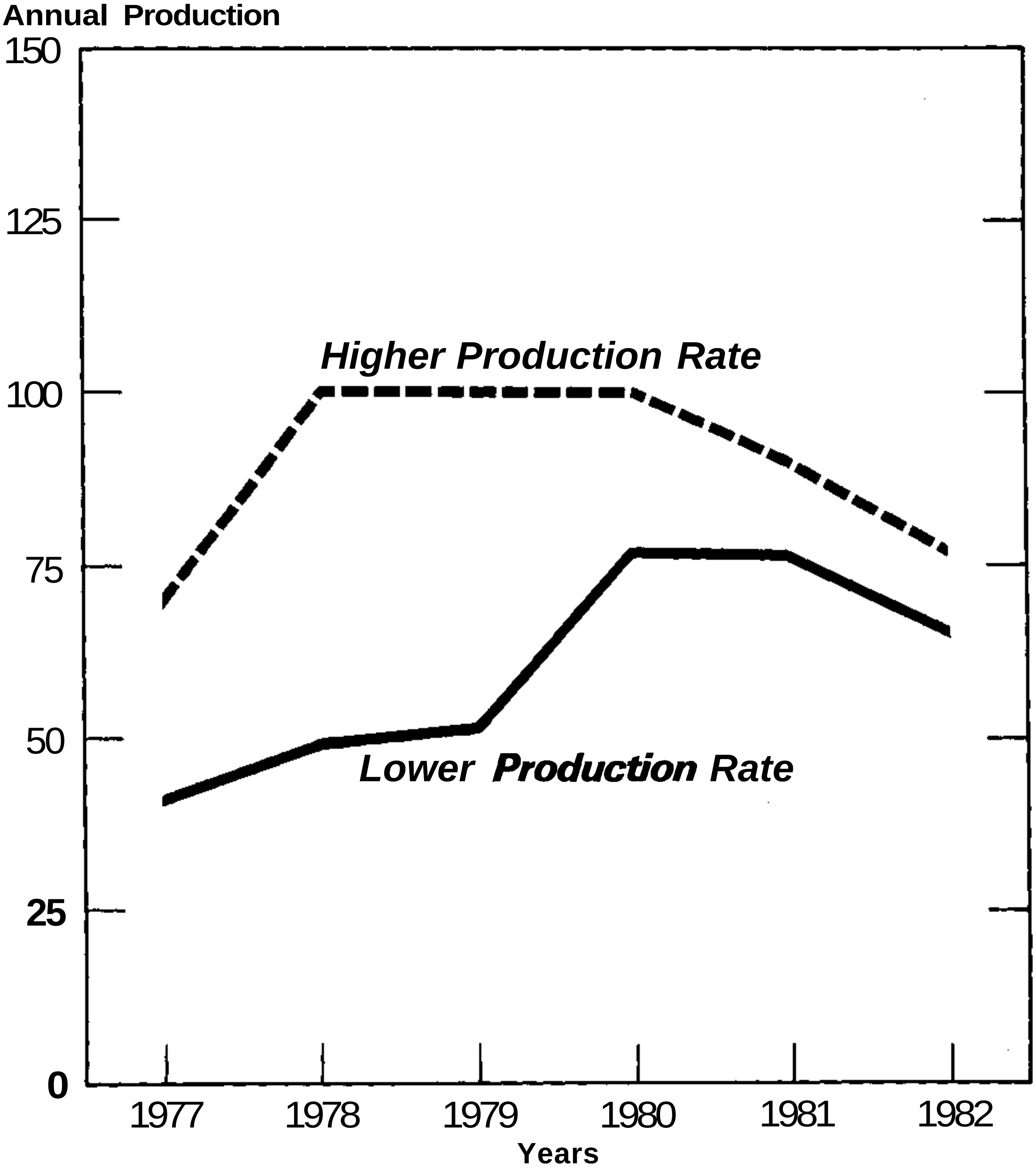
DERIVED RATES OF SALT DOME DEVELOPMENT, NPC TECHNICAL DATA



SOURCE: National Petroleum Council (NPC), "Draft Report: Petroleum Storage for National Security, "August 1975, P. 77. See Appendix C for description of the "Normal Development Schedule."

Figure 6.

CONSTRAINTS DUE TO INCREASES IN DOMESTIC OIL AVAILABILITY FROM NAVAL PETROLEUM RESERVES



Source: Appendix Table B-l

it would appear from the ESR plan that FEA would begin outfitting 261 million barrels of salt dome capacity during fiscal year 1977. It would complete 50 million barrels in fiscal year 1977, 150 million by fiscal year 1978, 233 million by fiscal year 1979, 325 million by fiscal year 1980, 426 million by fiscal year 1981, and 500 million by fiscal year 1982.

However, because an Environmental Impact Statement must be prepared for each site, the time tables set forth in the ESR plan probably should be modified for this delay. A somewhat arbitrary modification of the FEA schedule implied in its ESR plan can be found in Appendix C.

If NPR oil is to be used for storage or if receipts from the sale of NPR products are to be used for financing storage, the rate at which this oil is produced will be a restriction on the pace at which the storage capacity is filled. The "low rate" of NPR production shown in Figure 6 is detailed in Appendix Table B-I. It sets forth a fiscal year 1977 production of 41 million barrels, reaching a maximum of 77 million barrels in fiscal year 1980. A "medium production rate" is shown based on the schedule implicit in the President's fiscal year 1977 budget request. In this case production in fiscal year 1977 is 70 millon barrels and reaches a maximum of 100 million barrels in fiscal year 1978 (also detailed in Appendix Table B-I).

Alternative Fill Rates

The restriction just discussed have been used to develop alternatives which can be used for budget analysis purposes. Two different schedules for facilities and fill are used to generate these budget alternatives; one is based on NPC data, the other is based on FEA data (see Table 3).

Effects of Building the Stockpile on Import Vulnerability

Regardless of the source of fill (imported, domestic, royalty, or NPR), imports will increase while the oil is being stored. Any domestic oil, royalty oil, or NPR crude

TABLE 3

Alternative Rates of Fill
500 Million Barrel Program

	NPC Data[a]		FEA Data[b]	
	Facilities (million barrels capacity)	Fill (million barrels)	Facilities	Fill
April '76-Sept. '77	150	50	100	30
Oct. '77-Sept. '78	36	67	161	120
Oct. '78-Sept. '79	71	33	79	88
Oct. '79-Sept. '80	100	75	125	92
Oct. '80-Sept. '81	72	175	35	101
Oct. '81-Sept. '82	71	100	—	74

a. Based on NPC estimates for "normal development."

b. Based on modification of the schedule presented in FEA Early Storage Reserve Plan.

oil[7] used to fill the stockpile would otherwise be available for consumption. Consequently, satisfying domestic consumption and filling the stockpile would require imports larger than would be required to satisfy domestic demand alone.

Fill rates for a 500 million barrel and a 1 billion barrel program shown in Figure 7 were formulated to meet the schedule conditions mandated by EPCA. The 1 billion barrel program drops below the 500 million barrel program in fiscal year 1978 because EPCA mandates that 10 percent of whatever target is chosen be stored by July 1977, and that 150 million barrels must be stored by December 1978. Neither of these schedules significantly affects import vulnerabilities. If the country is importing 6 to 10 million barrels a day, an additional daily increase of .5 to .7 million barrels created by a 1 billion barrel storage plan is rather small. The increase created by a 500 million barrel plan--about .3 million barrels per day--is even smaller. Increases in imports of this magnitude would not significantly increase vulnerability to an embargo. An interruption which occurred during the fill period would presumably result in reserves already on hand being used and not replaced.

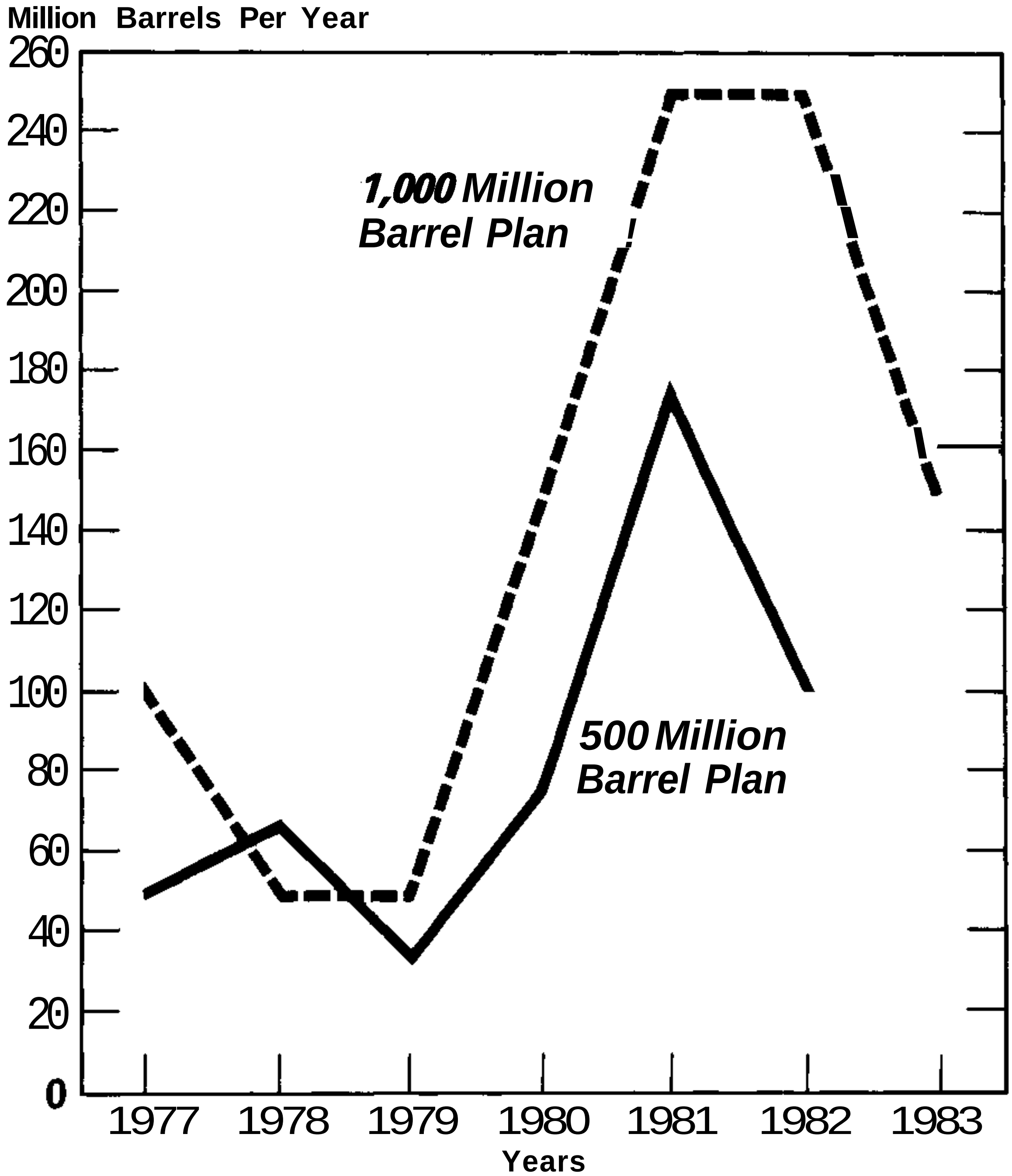
Conclusions

- The selection of a source of fill should be governed by the net cost of each alternative source;
- Regardless of source of fill, imports can be expected to increase during the fill period; however, no significant increase in import vulnerability is anticipated from schedules of fill considered;

7. This observation is partially influenced by the implications of continuing price controls and their effect on domestic demand. Only 90,000 of a possible 120,000 to 126,000 barrels per day of NPR oil were actually sold in July. For some reason, even at auction, the market was not cleared. Presumably the use of the 30,000 to 36,000 surplus for storage purposes would not necessarily mean an increase in imports.

Figure 7.

IMPLIED EPCA FILL RATES, 500 MILLION AND 1,000 MILLION BARRELS*



* Constrained by NPC facilities construction schedule

Source: Appendix C

- The achievable rate of fill depends on the relationship between construction schedules for facilities, availability of oil, and funding level;

- The desired rate of fill depends on the urgency of need for embargo protection and on the relative cost of different rates.

CHAPTER IV
COSTS AND BUDGET IMPACTS

Costs

The two major costs associated with a storage program are: (1) the capital costs associated with the construction of storage facilities, including storage cavities, pumping, pipeline and terminal facilities, and (2) the cost of crude oil or products to be stored. Operating and maintenance costs, once storage is in place, are small relative to costs of constructing and filling the facilities, and are not addressed in detail.

Once unit costs--average cost per barrel--based on facilities and sources of fill have been determined, the overall cost of the program can be estimated based on the size and filling schedule.

In this chapter, "cost" means the direct federal outlays associated with establishing the program, as opposed to economic costs.

It is important to note, however, that such a definition probably overstates the true costs of storage in a larger economic sense. At least some of the cost of acquiring the crude oil would be recovered once it is sold—whether in an emergency or for some other reason. Thus, the real costs of crude would be the carrying charges on the inventory of crude plus some allowance for physical deterioration while in storage (which might be minized by buying new crude and selling equal amounts of older stock), less any appreciation in the price of the crude. In this context, if storage in fact leads to an increase in imports, the economic cost is that associated with the highest-price import, regardless of the immediate source of the oil stored. Such a definition of cost would be appropriate for use in economic comparisons with other policy alternatives.

Unit budget costs are depicted in Table 4. They are average cost per barrel, calculated for various types of facilities and sources of crude. For facilities, the costs range from an estimated low of $0.85 per barrel of capacity for salt dome cavities to a high of $12.50 per barrel for above-ground steel tanks. For fuel, the costs range from $0.30 per barrel for oil produced from NPRs to a high of $14.00 per barrel for imports.

TABLE 4

ESTIMATES OF UNIT COSTS FOR STORAGE
FACILITIES AND FILL
(dollars per barrel)

Component	Cost Per Barrel
• Storage Facilities	
- Salt Domes or Mined Caverns	$.85 - 1.80
- Steel Tanks	$9.00 - 12.50*
• Crude Oil	
- NPR-1	$.30 - .50
- Domestic Crude	$5.05 - 12.00
- Federal Royalty Crude	$6.70 (average)
- Imported Crude	$12.00 - 14.00
• Total Cost	$2.35 - 26.50

SOURCES: NPC "Petroleum Storage for National Security"; FEA "Early Storage Reserve Plan", and Office of Naval Petroleum Reserves.

*A Case has been reported in which $3-$4/bbl cost for steel tanks were obtained. However, in absence of a detailed engineering study of that case and others, there does not appear to be sufficient rationale for altering the figures used here.

Using the cost factors identified in the previous table, a range of total cost estimates is presented in Table 5.

Precisely what costs are incurred in a given fiscal year will depend on the schedule for building and filling the storage (outlined in Chapter III), and on the source of fill. Five possible cases are presented below and detailed in Appendix C. All five cases lead to total capacity of 500 million barrels in salt domes (Figure 8); the differences are in source and schedule of fill.

	Source of Fill	Schedule of Fill
Case I	NPR plus imports	Derived from NPC data[1]
Case II	NPR plus imports	Derived from FEA data
Case III	Domestic production	Derived from NPC data
Case IV	Imports	Derived from NPC data
Case V	Imports	Derived from FEA data

It is clear from Table 5 and Figure 9 that both the source and rate of fill are important determinants of outlays. Total outlays for the five cases considered, including the costs of facilities and fill for 500 million barrels in salt domes, could range from $1.8 billion to $7.3 billion in undiscounted, constant 1975 dollars.

Although FEA has not yet submitted its complete storage plan, an estimate of the possible outlays required by such a plan is suggested based on the early storage reserve Plan (ESR) and cost benefit analyses, already prepared. Using the buildup schedule presented in Appendix C, and the average price shown in Table 5 for facilities and imported oil, Case V may approximate the FEA plan; it would cost $.7 billion for facilities and $6.6 billion for fuel, or $7.3 billion.

1. National Petroleum Council, "Petroleum Storage for National Security," P. 77.

TABLE 5

FLOW OF EXPENDITURES, 500 MILLION BARREL PROGRAMS
(Millions of dollars)

SCHEDULE: SOURCE OF FILL:	Case I NPC NPR +			Case II FEA NPR +			Case III NPC DOMESTIC			Case IV NPC IMPORTS			Case V FEA IMPORTS		
	Facilities	Fill	Total	Fac.	Fill	Total	Far.	Fill	Total	Fac.	Fill	Total	Fac.	Fill	Total
April '76-Sept. '77	210	75[b]	285	140*	45[b]	185	210	383	593	210	650	860	140*	390	530
Oct. '77-Sept. '78	50	100[b]	150	225	410[f]	635	50	511	561	50	867	917	225	1,560	1,785
Oct. '78-Sept. '79	100	50[b]	150	111	132[b]	243	100	255	355	100	433	533	111	1,143	1,254
Oct. '79-Sept. '80**	140	112[b]	252	175	138[b]	313	140	575	715	140	975	1,115	175	1,196	1,371
Oct. '80-Sept. '81**	100	1,240[e]	1,340	49	278[g]	327	100	1,341	1,441	100	2,275	2,375	49	1,313	1,362
Oct. '81-Sept. '82**	100	150[b]	250	-	111[b]	111	100	766	866	100	1,300	1,400	-	962	962
Total	700[a]	1,727	2,427	700[a]	1,114	1,814	700[a]	3,831[c]	4,531	700[a]	6,500	7,200[d]	700[a]	6,564[d]	7,264

a. Average facility cost--$1.40/barrel.

b. Average fuel cost--$1.50/barrel. ($.30 to $.50 production costs, plus $1.15 transportation to Texas).

c. Average fuel cost--$7.66/barrel.

d. Average fuel ccost--$13.00/barrel.

e. 90 million barrels of the required 175 millions are from NPRs, the maximum production that year, at $1.50 per barel. The remaining 85 million barrels is imported crude at $13.00 per barrel.

f. 100 million of the minimum 120 million barrels is provided by the maximum NPR production that year at $1.50 per barrel. The remaining 20 million barrels is from imports at $13.00 per barrel.

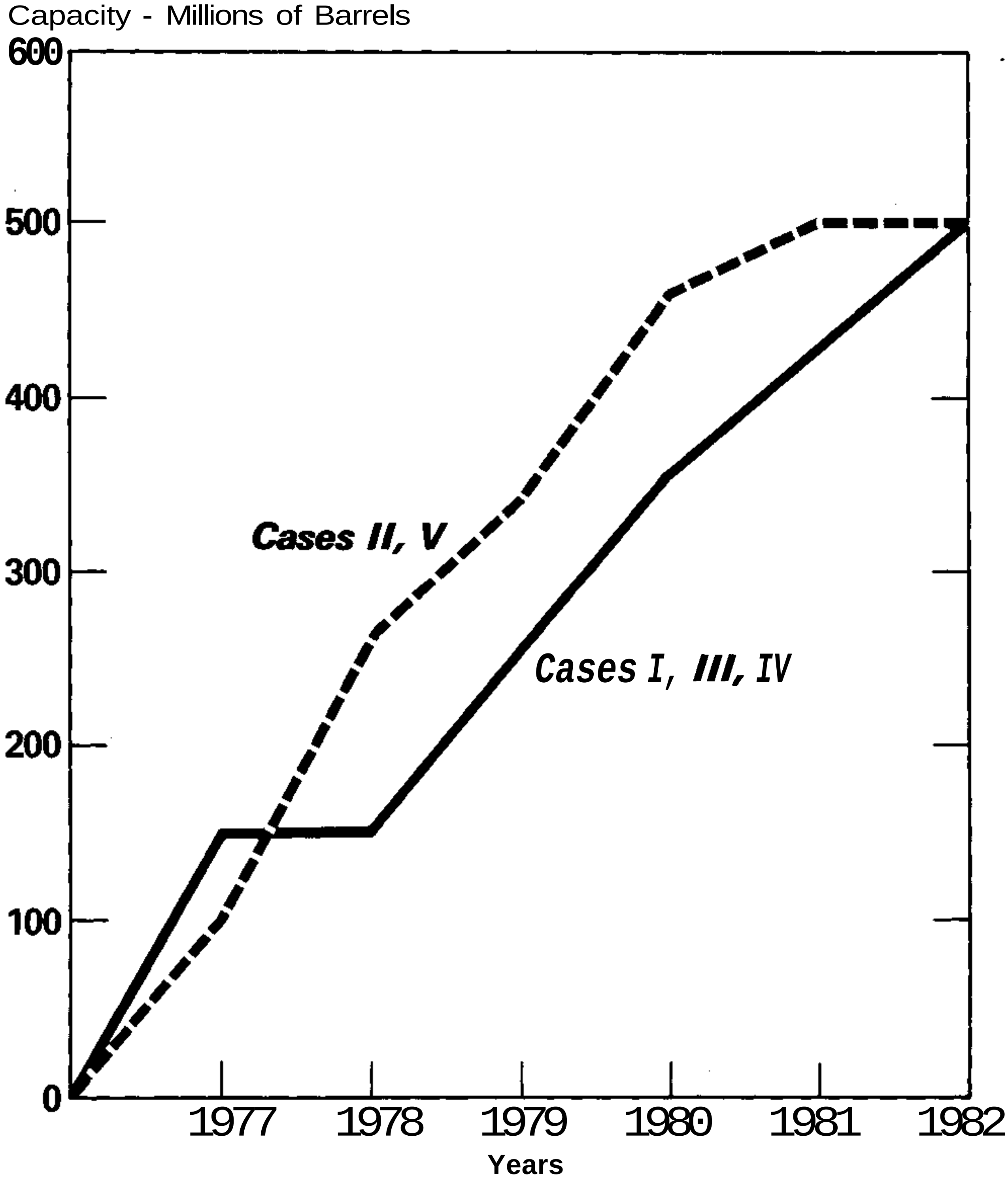
g. 90 million of the required 101 million barrels is provided by the maximum NPR production that year at $1.50 per barrel. The remaining 11 million barrels is from imports at $13.00 per barrel.

* FEA's budget request for FY '77 indicates that $313 million will be spent for 261 million barrels of capacity. It is unlikely that FEA will meet this schedule, and it has been reduced here for analytical purposes.

** Operating expenses can be expected to approximate 50 million dollars per year in each of the five scenarios beginning in the fourth year of the program.

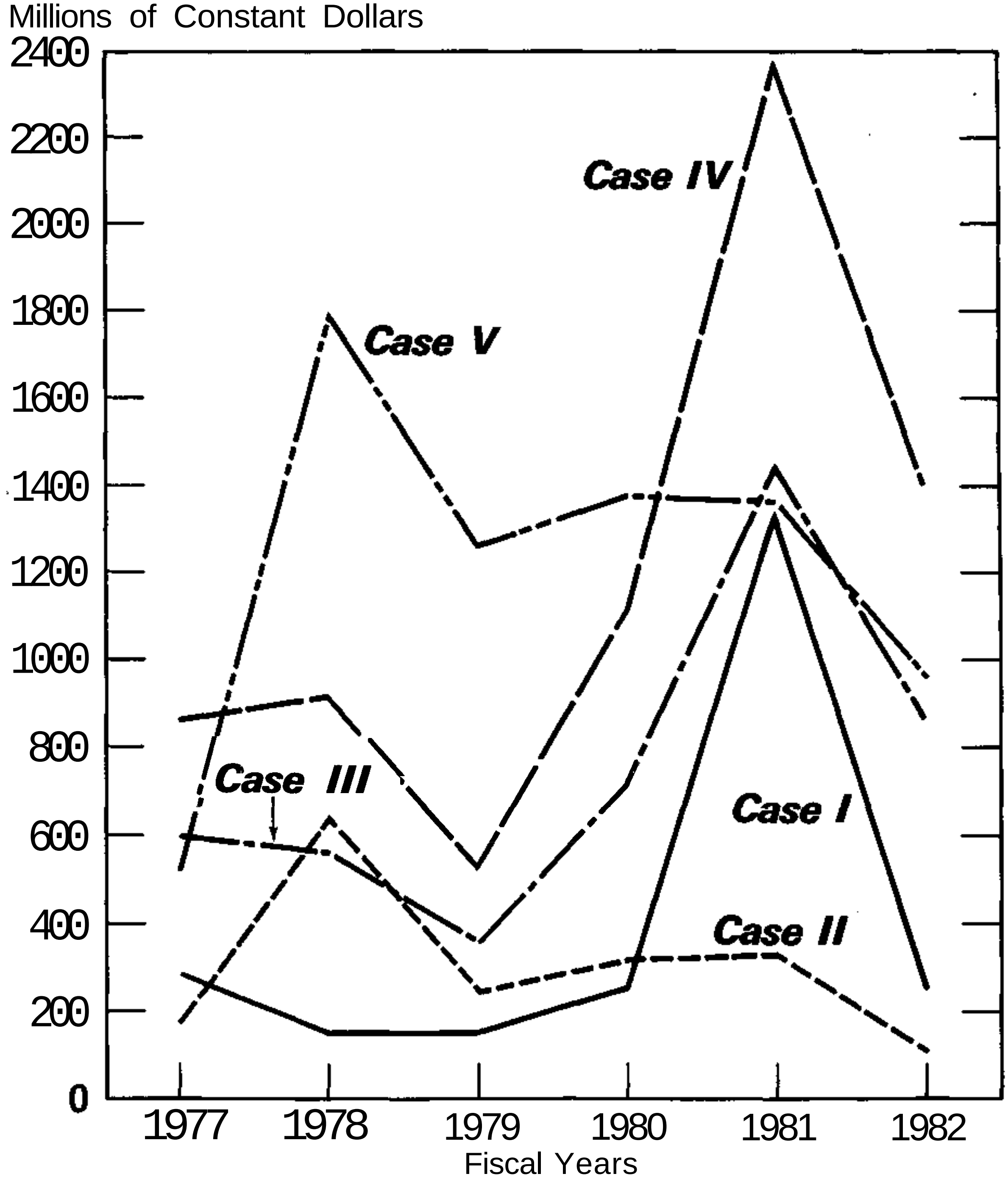
Figure 8.

STORAGE CAPACITY



Source: Appendix C

Figure 9.
OUTLAYS OF VARIOUS PETROLEUM STORAGE OPTIONS



Source: Table 5

FEA's Cost-Benefit Analysis provides an estimate of annual operating costs of approximately $50 million, over a 15-year period. This level of operating costs is assumed to be reached in the fourth year of the program. However, they are not included in the totals shown in Table 5. A final decision on the ultimate size of the reserve has not been made at this time; however, it is apparent that FEA intends to submit plans based upon a 500 million barrel program. Accordingly, the possible budget impacts of a 500 million barrel program have been discussed in detail. The possible costs of a smaller or larger program are illustrated in Table 6 to facilitate comparisons. Table 6 briefly outlines the costs of a 150 million barrel program, the minimum permitted by EPCA, and a 1 billion barrel program, the maximum permitted by EPCA. The Table shows costs based on the derived FEA schedule for imports and NPR fuels, Cases II and V.

Budget Implications

Outlays and Budget Authority

The expenditure estimates developed for Table 5 are considered to be outlays, without need of further modification.

The relationship between budget authority and outlays may be difficult to predict in this program. There is little relevant programmatic experience; thus planning estimates are the only guide. FEA's budget request argues for significant budget authority and "no-year" money, to give it the flexibility which would allow it to provide for the more expensive outcomes (even though it intends to strive for low-cost options), and to allow FEA to proceed with its plan without undue concern for the pace of funding. Table 7 shows budget authority which would be required for the outlays shown in Table 5, assuming a specified relationship.[2]

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2. $BA_n = \dfrac{Outlay_n - .2BA_{n-1}}{.8}$, where n=(1 to 4) years

$$BA_5 = Outlay_5 - \sum_{n=1}^{4} (BA-Outlays)_n$$

$$BA_6 = Outlay_6 - \sum_{n=1}^{5} (BA-Outlay)_n$$

TABLE 6

OUTLAYS FOR VARIOUS PETROLEUM STORAGE PROGRAMS 1977-1986
(Million 1975 Dollars)

Program Size (barrels)	Source	77	78	79	80	81	82	83	84	85	86	Total
150 million	(Imports)	530	1,795	56	56	56	54	54	54	54	54	2,753
	(NPR)	185	635	56	56	56	54	54	54	54	54	1,258
1 billion	(Imports)	1,432	832	1,496	2,230	3,530	3,530	1,300	54	54	54	14,562
	(NPR)	722	257	346	1,155	2,735	2,911	605	54	54	54	8,893

TABLE 7

BUDGET AUTHORITY IN '75 DOLLARS (MILLIONS)*

	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82
Case I	356	99	162	275	1,285	250
Case II	231	736	120	361	255	111
Case III	741	516	315	815	1,278	866
Case IV	1,075	877	447	1,282	2,119	1,400
Case V	663*	2,065	1,051	1,451	1,072	962

*FEA has requested $313 million in BA, $5 million outlays for FY 76; $558 million in BA, $790 million in outlays for FY 77. Total FEA request for early storage in FY 76 and FY 77 is $871 million in BA and $795 million in outlays, approximating Case IV. The Congress approved in the First Concurrent Resolution, $313.0 million in BA for FY '76 and $447.0 million in BA for FY '77. Current Policy estimates of outlays are $5.0 million for FY '76 and $347.0 million for FY '77.

Offsetting Receipts

To a large extent, the question of financing hinges on whether the storage is owned and controlled by industry or by government. EPCA has mandated a government-controlled early storage program, but allows FEA to establish an industrial petroleum reserve as part of the strategic petroleum reserve. FEA calculates that the law would permit a maximum of about 183 million barrels to be stored by industry under this provision,[3] which would imply partial ownership by industry and some industry financing. However, the regulations required to implement such a provision have not as yet been determined. The option does not appear in the FEA plan for early storage. Hence, this discussion assumes that the program will be wholly financed by the federal government.[4]

The Naval Petroleum Reserves Production Act of 1976 (P.L. 94-258) authorizes the use of receipts from sales of petroleum from NPRs to offset storage outlays as well as for production costs and development of NPR 4. This provision would minimize new net outlays for storage. However, it should be recognized that, without a storage program, NPR receipts would increase general revenues for whatever purpose.

Offsetting receipts from NPR sales of crude from fiscal year 1977 to 1981 have been estimated in the President's fiscal year 1977 budget request and are shown in Table 8, along with an estimate based on a lower rate of production. The estimate in the President's budget is extended one year using assumptions implicit in the first five years. In Table 9 offsetting receipts are shown for each of the five cases.

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3. 3 percent of imports in 1975.

4. If the objective of an Industrial Petroleum Reserve is to cause users of petroleum to share the burden of financing storage, a similar result could be achieved by an excise tax on petroleum.

TABLE 8

ESTIMATES OF OFFSETTING RECEIPTS
FROM NAVAL PETROLEUM RESERVES (BILLIONS)

	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	6-year Total
President's Budget ($10/barrel)	0.7	1.0	1.0	1.0	0.9	0.8	5.4
Same Schedule, but $11.50/barrel	0.8	1.2	1.2	1.2	1.0	0.9	6.3
Low rate of Production* $11.50/barrel	0.5[a]	0.6	0.6	0.9	0.9	0.7	4.2

a. FY 77 receipts of $.5 billion are predicated upon an annual production and sale of 40.7 million barrels of $11.50 per barrel. (An average of 112,000 barrels per day). So far, sales for FY 77 are 90,000 barrels per day or 32.9 million barrels for the year. If this lower rate holds receipts for FY 77 will be less than $.4 billion.

* The production rate used in this calculation is shown in Appendix C, Table C,

TABLE 9
ESTIMATES OF OFFSETTING RECEIPTS
BY CASE (BILLION 1975 DOLLARS)

	FY 77	FY 78	FY 79	FY 80	FY 81	FY 82	6-year Total
Case I (NPR production[a] is used for storage to maximum extent possible)	.23	.43	.77	.29	*	.02	1.74
FEA Schedule (where all NPR production[a] is used for storage until reqiurements for year are satisfied)	.46	*	.14	.09	*	.03	0.72
Case III[b]; Case IV[b]; FEA Schedule[b] (where storage uses imported fuel only)	.81	1.15	1.15	1.15	1.04	.88	6.18

a. Production Schedule implied by President's FY '77 budget.

b. All NPR production is sold at $11.50/bbl.

*A year in which NPR production is insufficient to provide for storage requirements, hence no receipts are realized.

In calculating outlays for petroleum storage net of receipts from NPR sales, only a portion of the production costs associated with producing NPR oil are taken into account. The costs of developing NPR 1, 2, and 3 are treated as inherent costs, since that development would have taken place with or without the strategic storage program. Similarly, exploration and development costs of NPR 4 in Alaska have not been included in the costs of the storage program. Accordingly, only the lifting costs of NPR oil actually used for storage are included in calculating net outlays.

Table 10 shows net outlays for each case. In Case III, in which oil is purchased at average regulated prices, aggregate receipts are greater than outlays. In every other case, total outlays exceed total receipts. However, in the early years of the program, receipts generally exceed outlays. Outlays are smallest in Case *I* where the fill schedule is more in tune with production from the NPRs. In Case II NPR oil used for storage is, in effect, purchased by FEA at $11.50 per barrel plus $1.50 cost of production and transported to Texas, for a total cost to FEA of $13 per barrel. The total cost of using a barrel of NPR oil in Case II is thus equal to the cost of a barrel of imported oil in Cases IV and V. However, if the price of NPR oil falls significantly below $11.50 per barrel, Case II begins to cost significantly less than Cases IV and V.

In each of the cases examined, NPR receipts were based upon the production schedule implied in the President's fiscal year 1977 budget. (See Appendix B Table B-1.) Over the six-year period, 1977 to 1982, production at that rate would be sufficient in the aggregate to provide for both storage and income. At the lower production rate in Table B-1, NPR oil cannot be made available in sufficient quantities to provide for all storage needs.[5]

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5. Revised production estimates for fiscal year 1977 point to production from NPR 1 reaching 89,800/bbl per day by November. At this rate, annual production would be about 32.8 million barrels, plus 1.2 million from NPRs 2 and 3, or 34 million barrels.

TABLE 10

TOTAL STORAGE OUTLAYS NET OF RECEIPTS FROM NPR SALES

	FY '77	FY '78	FY '79	FY '80	FY '81	FY '82	6-year Total
Case I	.055	(.279)*	(.620)	(.035)	1.340	.233	0.694
Case II (where all NPR production is used for storage until rquirements for the year are satisfied)	(.275)	.635	.098	.221	.327	.092	1.088
Case III	(.22)	(.59)	(.80)	(.44)	.40	(.01)	(1.62)
Case IV	.05	(.23)	(.62)	(.04)	1.34	.52	1.02
Case V	(.280)	.635	.097	.221	.322	.082	1.077

* () means net receipts.

Conclusions

- The budget costs of a 500 million barrel storage plan will not be completely offset by NPR sales.
- As long as the price of NPR oil is $11.50 or greater, no significant advantage results from using it directly for storage in lieu of imported oil at $13.00. However, this fact does not take away from the advantage of using excess NPR oil (that which is not sold) for storage.
- Total outlays for storage, net of NPR receipts, between fiscal year 1977 and fiscal year 1982 will range from $700 million to $1.1 billion.

CHAPTER V
MANAGEMENT CONSIDERATIONS

Two major management considerations affect the selection of an implementation plan for petroleum storage: the selection of storage facilities and the stipulations regarding drawdown of the reserve.

What Kind of Storage Facilities should be Employed?

Three major types of storage facilities could be employed: salt domes, mined caverns and steel tanks.

Salt domes are geologic structures located primarily in the Gulf Coast states of Texas, Louisiana, Mississippi and Alabama. These structures are columns of rock salt that overlay formations and protrude toward the earth's surface. There are some 350 formations in the Gulf Coast states and offshore tide lands. Historically these formations have been associated with mining of salt, sulfur and petroleum.[1]

Cavities can be created in salt domes by leaching out the salt with water, using much of the technology and equipment already associated with drilling for oil or with mining for various chemicals. The process for creating a cavity in a salt dome is similar to the solution mining technique. these cavities can be used for the storage of liquid petroleum gas or crude oil. (Figure 10.)

Salt domes have been used for the storage of petroleum products, beginning in 1951 with the storage of liquid petroleum gas (LPG) in underground cavities dissolved in the salt. The practice has developed extensively since then. A number of cavities, consequently, already exist.

In 1964 storage capacity was estimated at 57 million barrels. In 1975 FEA estimated existing capacity in excess of 200 million barrels.

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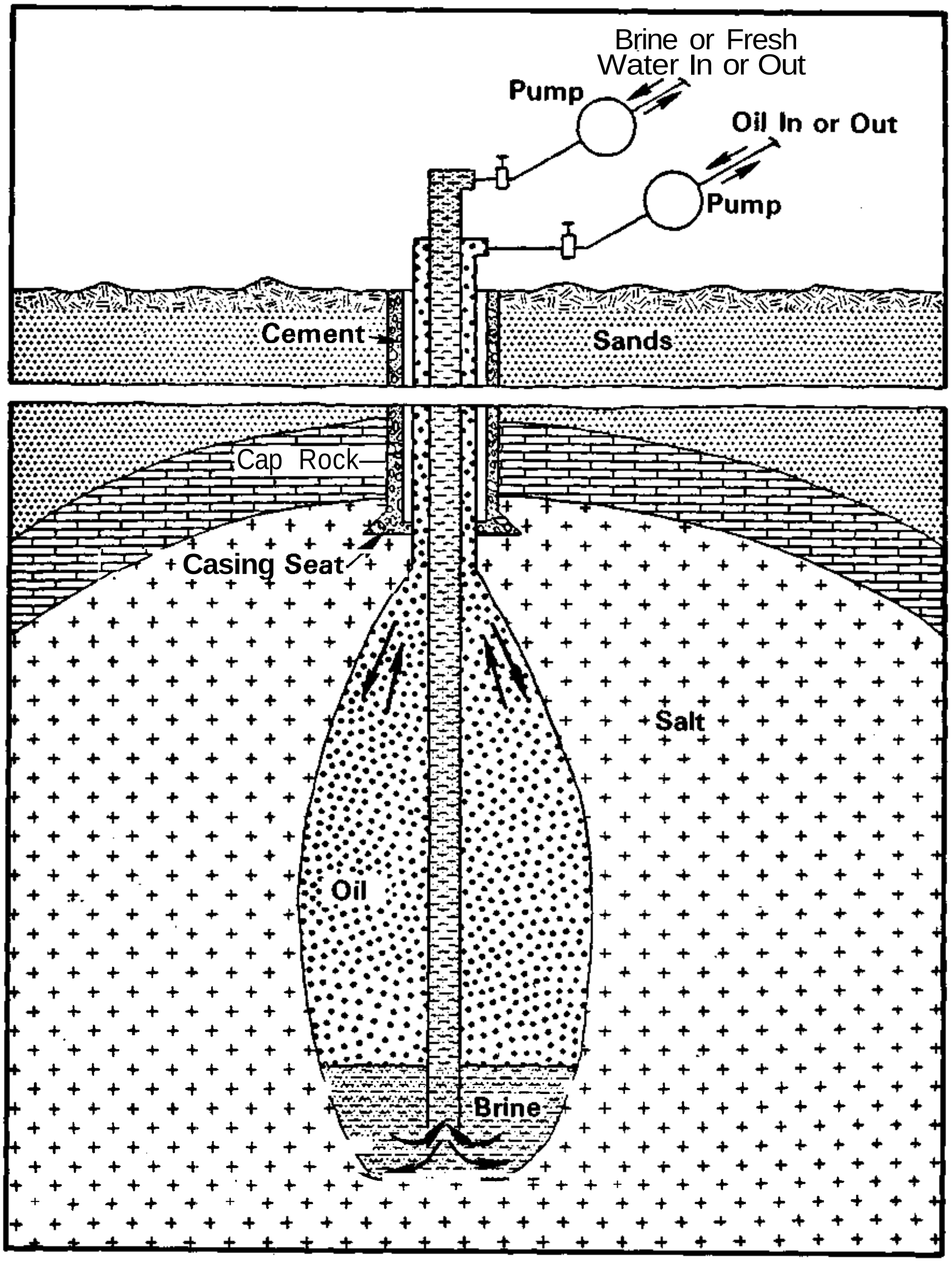
1. This discussion is based on Bureau of Mines Information Circular 8313, Salt Domes in Texas, Louisiana, Mississippi, Alamba, and Offshore Tidelands: A Survey by M.E. Hawkins and C.J. Jirik, 1966.

Figure 10

SCHEMATIC DIAGRAM OF AN OIL STORAGE OPERATION IN A SALT DOME



Reproduced from Hawkins and Jirik

Creation of storage capacity in salt domes will necessitate the use of considerable quantities of fresh water (or greater quantities of sea water), and disposal of the brine solution. 7.5 to 8.0 barrels of fresh water are needed to leach one barrel of storage capacity.

Above-ground steel tanks, though extremely expensive, can be located anywhere in the country. Steel tanks are considered by some to be more subject to leaks and spills than salt domes, with resulting environmental hazards. Tanks are also more vulnerable to sabotage.

Mined caverns can in many cases be converted for storage at costs similar to those of constructing salt domes. However, their location and availability will determine the feasibility of using them in any given storage program.

The selection of a specific combination of storage facilities will have to balance the obvious cost considerations against environmental, location and availability factors. The details of such selection are not addressed in this paper. The budget estimates presented in Chapter V presume--with FEA--that the facilities with lowest initial cost--salt domes--will be employed.

<u>When and By Whom Should the Reserve Be Emptied?</u>

The effectiveness of a storage program in achieving the policy objectives for which it was designed depends on the way in which the reserve is emptied. Indeed, the responsiveness of the reserve drawdown strategy could influence the optimal size of the reserve. No analyses have yet reached this level of sophistication. Nevertheless, while the drawdown strategy is not a budget issue in the near term, the use of the reserve will determine its effectiveness. Problems of effective use include estimating the duration and level of an embargo, once it has begun, and accordingly deserve continuing attention as plans and implementation develop.[2] Priorities determining which users should

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2. FEA import data for the period covered by the last embargo, show a drop in total imports (crude and refined) of 814,000 barrels/day from November to December 1973. In January 1974 imports were 1,514,000 barrels/day below November 1973 levels; 1,648,000 in February 1974; 1,654,000 below in May of 1974 and 899,000 below in April.

receive shipments and in what proportions, will bear some relationship to the standby energy authorities that might actually be implemented.

Drawdown decisions can be made continuously, depending on a constant flow of information pertaining to production, imports and consumption. A premise could be devised in which the reserve would never be reduced to zero.

Another approach would be to schedule the use of the reserve in conjunction with anticipated additions to capacity from higher-cost sources of energy, such as synthetic gasoline from coal. One might also structure drawdown schedules contingent upon the actual enactment of specified conservation measures, such as lower speed limits, and revised office hours.

In any of these situations the need for information concerning the intentions of those nations enforcing the embargo is readily apparant. An embargo imposes economic losses on the nation that is responsible for it as well as on its victim, at least in the short run. Consequently, an embargo is likely to take place in an economic and political context that involves other issues. It is unlikely to be an isolated event. The strategic reserve in this context becomes an instrument of U.S. foreign policy in the same sense that military resources are. Clearly, the management apparatus for using the reserve must reflect those wider interests.

The economic consequences of fuel shortages can be translated into changes in relative prices. A drastic increase in fuel prices can be just as harmful as an actual reduction in the flow of oil. To the extent that economic interests govern the actions of the cartel, price manipulations might be more likely than an actual embargo. There are no provisions in EPCA for response to price manipulation.

In addition to the problems associated with release of fuels in the event of an actual embargo, there is another set of problems associated with the non-occurrence of an embargo, and a possible long-term decline in import vulnerability. In a long-term situation in which dependency on oil has been significantly reduced, the precipitous dumping of millions of barrels of oil on the market would depress oil prices even further. As discussed earlier, similar situations exist from time to time with various strategic materials. For example, the government owns major stocks of certain strategic metals (in many cases constituting a major share of annual production) and must obtain Congressional approval prior to the sale of those metals. One possible result of a condition like this would be the necessity to retain oil in storage long after its insurance value had disappeared. Perhaps, the release plan should provide a trigger gauged to decreasing thresholds of vulnerability.

APPENDIX A
OTHER USES OF STRATEGIC STORAGE

The United States government has pursued storage policies with other commodities for a variety of reasons. Stockpiles of strategic materials, such as silver and manganese, have been maintained against possible interruption associated with war. Stockpiles of wheat and other agricultural commodities have been accumulated as a result of efforts to support and stabilize farm incomes. Surplus commodities were acquired at some minimum price. Over the last decade large government-held stocks of U.S. grain were disposed of in the world market so as to lower budget costs. Few predicted the large production shortfalls that occurred in 1972 and again in 1974. Thus, the large grain stocks of the previous decade were not available when they could have been most useful.

Currently, the U.S. is considering participation in the United Nations Conference on Trade and Development (UNCTAD). The objective of this conference is to establish price-stabilizing agreements on many raw materials that are exported by "Third World Countries." The creation of stockpiles is being considered for a number of commodities.[1]

While the petroleum situation may be considerably different from the situations with respect to wheat, strategic materials, and other commodities, the price implications of the existence of stockpiles are similar in kind. Large reserves of wheat were acquired when wheat prices were relatively low (in the interest of keeping wheat prices above minimum), and disposed of when those prices were still relatively low, prior to the 1973 spiral in wheat prices. Table A-1 illustrates the rapid decline in government owned stocks during the last decade.

The planned disposal of emergency commodities in the President's fiscal year 1977 budget is one example of alternative uses of a strategic reserve. Sales of strategic materials (chrome, cobalt, diamonds, lead, manganese, platinum, silver, tin, tungsten and zinc) would yield an estimated $1.05 billion in receipts.

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1. Wall Street Journal, July 19, 1976, P. 14.

There has been a dramatic increase in oil prices in the past two years. Expectations as to the future long-run average price of petroleum are even higher. Much depends on the cohesiveness and discipline of the oil exporting cartel in getting their members to restrict current production and stick to higher prices. Given the considerable uncertainty concerning the responsiveness of oil production and demand to changes in price, it is not possible to say definitely what future supply and demand equilibrium conditions will be. Nevertheless, Federal Energy Administration (FEA) studies used to establish domestic production and import expectations associated with the 1975 Administration Energy proposals assumed a $7/barrel average oil price at well-head and a $2 import fee. The EPCA establishes domestic ceilings at an average price of $7.66/barrel. FEA studies in support of its 1975 Energy Proposals show imports decreasing to zero if domestic prices reach $11.00 per barrel in 1985 assuming enactment of proposed conservation and supply measures. Current FEA estimates of the domestic price at which imports reach zero, are $16.00 per barrel. Whatever the appropriate zero import price may be, the need for insurance against the interruption of imports would vanish, when that price is reached. In this instance, oil reserves might serve as a hedge against price increases after 1985. (Oil reserves in that context would be available for a price stabilizing function not unlike that which has been sought in wheat stockpiles.) If the EPCA mandated price of $7.66 were to remain in effect, a considerable volume of imports would be required by 1985 to offset domestic production shortfalls. The reserves, accordingly, would be performing their designed function of providing insurance against import interruptions.

TABLE A-1

RATIO OF TOTAL STOCKS TO DISAPPEARANCE[a] WHEAT

	Stocks owned[b] by CCC M. Bushels	Total Stocks[c] M. Bushels	Ratio Total Stocks to Disappearance	Season Avg. Price to Farmers $1 Bushel
1962	1,096.6	1,322.0	107 %	2.04
1963	1,082.5	1,195.2	82 %	1.85
1964	828.9	901.4	65 %	1.37
1965	607.7	817.3	51 %	1.35
1966	262.1	535.2	37 %	1.63
1967	123.6	424.4	30 %	1.39
1968	102.3	538.5	38 %	1.24
1969	162.7	816.7	63 %	1.25
1970	301.2	884.9	64 %	1.33
1971	369.9	731.5	48 %	1.34
1972	366.5	863.5	58 %	1.76
1973	209.2	438.5	22 %	3.82

SOURCE: United States Department of Agriculture, "Agricultural Statistics 1974".

a. Disappearance includes total domestic consumption plus exports.

b. Commodity Credit Corporation, government-owned stock.

c. Total Stocks include stock privately held and government-owned.

APPENDIX B
PRODUCTION AND DISTRIBUTION DATA FOR NAVAL PETROLEUM RESERVES

Table B-I in this appendix outlines the possible use of production from Naval Petroleum Reserves for storage, or as an addition to the domestic market for consumption. Data is presented based on two different rates of production. Production in each of these two instances is made available for storage in accordance with either a schedule of fill derived from NPC data, or a schedule of fill derived from FEA data.

TABLE B-1

POSSIBLE DISPOSITION OF PRODUCTION FROM NAVAL PETROLEUM RESERVES (NPR) 1, 2, & 3

	Fiscal Year	Rate of Production Government-Owned (Million Barrels)		Derived NPR Schedule[c]: Possible Storage Fill Rate Per Year[c] (Million Barrels)	Derived NPR Schedule[c]: Net Domestic Addition of NPR Fuels to Market (Million Barrels)	Derived NPR Schedule[c]: Receipts From NPR Sales, $11.50/bbl.	Derived FEA Schedule[b]: Possible Storage Fill (Million Barrels)	Derived FEA Schedule[b]: Net Domestic Addition of NPR Funds to Market (Million Barrels)	Derived FEA Schedule[b]: Receipts From NPR Sales, $11.50/bbl.
		Total	NPR#1 only		(Deficit)	$ millions			$ millions
Lower Rate of Production[a]	1977	40.715	(37.960)	50.000	(9.285)	(120. 705)[d]	30.000	10.715	123. 223
	1978	48.887	(41.040)	67.000	(18.113)	(235. 469)[d]	120.000	(71.113)	(924. 469)[d]
	1979	50.644	(44.640)	33.000	17.644	202. 906	88.000	(37.336)	(485. 368)[d]
	1980	76.796	(73.000)	75.000	1.796	20.654	92.000	(15.204)	(197. 652)[d]
	1981	76.057	(73.000)	175.000	(98.943)	(1,286.259)[d]	101.000	(24.943)	(324. 259)[d]
	1982	65.000	(62.050)	75.000	(10.000)	(130. 000)[d]	74.000	(9.000)	(117. 000)[d]
	TOTALS	369.099				(1,548.873)			(1,925.520)
Higher Rate of Production (Schedule implicit in President's FY '77 Budget)	1977	70.000	-------	50.000	20.000	230.000	30 000	40 000	460.000
	1978	100.000		67.000	33.000	429. 000	120.000	(20.000)	(260. 000)[d]
	1979	100.000	-------	33.000	67.000	770.500	88 000	12 000	138.000
	1980	100.000	-------	75.000	25.000	287.500	92 000	8.000	92.000
	1981	90.000		175.000	(85.000)	(1,105.000)[d]	101.000	(11.000)	(143. 000)[d]
	1982	76.500[e]	-------	75.000	1.500	17.250	74.000	2.500	28.750
	TOTALS	536.500				(629.250)			315. 750

a. Production schedule depicted in Senate Interior Committee Report, production from NPR#1 is initially constrained by pipeline capacity, of 130,000 barrels then 155,000 barrels per day. Capacity eventually reaches a maximum of 250,000 barrels per day. NPR#1 figures are government share of total production (80%). Production drops at 15% per year after 1981.

b. Details pertinent to this schedule are at Appendix C.

c. Assumes maximum use of NPR production for storage (either directly, or on an exchange basis).

d. Assumes deficit NPR production will be made up by purchase of imported crude at $13.00 per barrel.

e. The President's '77 budget does not provide data for FY '82. We have assumed that production drops at 15% per year after FY '81.

APPENDIX C
FIVE ALTERNATIVE CASES BUILDING A 500 MILLION BARREL PETROLEUM RESERVE

Prior to outlining the cases, the two underlying schedules for completing storage facilities and filling them are shown. The first schedule is derived from NPC data, the second from FEA data.

NPC Schedule

1. The first 150 million barrels of storage capacity will be from a combination of converted existing solution mined caverns in salt domes and from converted mines. Many of these facilities can be completed by July 1977.

2. Fifty million barrels of crude will be provided and stored by July 1977.

3. Another 100 million barrels of crude will be provided and stored by December 1978.

4. The remaining 350 million barrels of storage capacity will be mainly new leached caverns in salt domes; their construction would begin in January 1977 and be completed in accordance with a moderate sample schedule which NPC regards as feasible.[1] (See Table C-1).

5. With the construction schedule suggested, filling could begin after work progresses on the leaching of caverns. It need not wait until the caverns are completely leached. Accordingly, filling for the first 175 million barrels could begin in the period of October 1979-September 1980 and be completed by December 1980. The second

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1. NPC Draft Report: Petroleum Storage for National Security, August 1975, P. 77.

TABLE C-1

Construction Schedule for Remaining 350 Million Barrels of Capacity

Cumulative Time from Approval of Implementation Plan	Period in which Phase is Completed	Nature of Work
9 months	Jan. '77-Sept. '77	Environmental studies and engineering design. Complete engineering design, order long lead time materials.
18 months	Sept. '78-June '79	Deliver of well casing, begin drilling and construction.
27 months	July '78-March '79	Delivery of all pumps, pipes, etc.
30 months	April '79-June '79	Begin cavern leaching.
32 months	Aug. '79-Sept. '80	Begin filling as leaching continues.
48 months	Dec. '80	Complete first half of caverns (175 million barrels; 12-15 caverns.
66 months	June '82	Complete second half of caverns. (175 million barrels; 12-15 caverns.

increment of 175 million barrels would begin in the July 1980-July 1981 period and be completed by July 1982. The production schedule in Appendix Table B-I indicates how much of that fuel would come from NPRs. The shortages will be provided by imports.

FEA Schedule

1. FEA's Early Storage Reserve Plan has outlined a schedule for filling the reserve. That schedule is subject to change as the process of constructing facilities begins to encounter difficulties. Currently, FEA planners do not feel they will meet the EPCA mandated target of 50 million barrels by July 1977. This delay is due to dificulties encountered in initiating construction at storage sites. As of this writing, (August 1976), FEA planners are unwilling to stipulate a new schedule. Accordingly, we have presented here the original FEA schedule, below which is indicated what we estimate will be the likely schedule of fill. Along with the fill schedule we have also presented a schedule for facilities. These schedules will be referred to as FEA schedules and used in calculating expenditures. (See Table C-2).

Defintion of Cases:

Case I - NPC Schedule, fill from NPRs (as much as possible).

Case II - FEA Schedule, fill from NPRs (as much as possible).

Case III - NPC Schedule, fill from domestic production.

Case IV - NPC Schedule, fill from imports.

Case V - FEA Schedule, fill from imports.

TABLE C-2
ESR AND SPR OIL STORAGE RATE PLAN*

CALENDAR YEAR (QUARTERS)

	1976			1977				1978				1979				1980				1981				1982				Sub Total
	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
Projected Total Crude Storage Fill Rate:																												
Incremental (MMB)				50				100												101								
Cumulative (MMB)						50				150				233				325				426				500		500
Rate (MB/D)				185				222												281								
Cumulative Total (MMB)						50				150				233				325				42C				500		500

* SOURCE: FEA Early Storage Reserve Plan, April 22, 1976.

ESTIMATED MODIFICATIONS TO FEA SCHEDULE

CALENDAR YEARS (QUARTERS)

	1976			1977				1978				1979				1980				1981				1982			
	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Fill Rate Cumulative (MMB)						30				150				233				325				426				500	
Facilities Cumulative (MMB)						L00				261				340				465				500					

APPENDIX D
OTHER CBO PAPERS ON ENERGY

Additional insight into energy policy issues is provided in a series of background papers, prepared by the Congressional Budget Office's (CBO) Natural Resources Division, which appear from time to time. Those currently available from CBO's Office of Intergovernmental Relations (225-4416) include:

"Commercialization of Synthetic Fuels: Alternative Loan Guarantee and Price Support Programs," CBO Background Paper #3, January 16, 1976.

"Uranium Enrichment: Alternatives for Meeting the Nation's Needs and Their Implications for the Federal Budget," CBO Background Paper #7, May 18, 1976.

"Energy Research: Alternative Strategies for Development of New Energy Technologies and Their Implications for the Federal Budget," CBO Background Paper #10, July 15, 1976. Underlying data and methodology are reported in "Federal Energy Research: An Analysis of Fiscal Year 1977 Program Funding Levels and Alternative Budget Paths Through Fiscal Year 1986," Technical Staff Working Paper, September 10, 1976.

"Financing Energy Development," CBO Background Paper #12, July 26, 1976.