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Planning and Development of Superports– A Partial Solution to the Energy Crisis

by

*Paul D. Cribbins**

ONE OF THE MOST perplexing problems facing the free world today is how to meet the growing demand for energy. Few question that a crisis is imminent but there is little agreement on how to solve it. Energy shortages are not unique to the United States. With the notable exception of the Soviet Union, most major industrial nations do not have sufficient domestic supplies of fuel to satisfy their demands and must turn to energy rich, underpopulated regions of the world for their deficiencies. Moving these vast quantities of low-value bulk commodities from origin to consumer in a cheap, safe, and environmentally acceptable manner is where the controversy begins. This paper will first review the seriousness of the energy crisis, particularly in the United States, and compare the most likely alternatives for attacking it in the period 1973 to 1985. A case will then be presented for drastically increasing U.S. imports of petroleum and natural gas and constructing a modern fleet of supertankers and liquefied natural gas carriers to transport them. Monumental problems in the design and construction of the ports and terminals needed to accommodate these superships will be explored. After reviewing the success enjoyed by other nations in developing offshore facilities, arguments will be presented for immediate planning and construction of at least two offshore superports in the U.S., one to serve the major energy market in the North Atlantic Region and the other to serve the petrochemical industry along the Texas-Louisiana Gulf Coast, as part of a comprehensive energy supply system that would include ancillary ship and pipeline subsystems.

THE IMPENDING CRISIS IN ENERGY SUPPLY

The much publicized crisis in the supply of energy is already a reality and the era of low-priced energy derived from gas and oil is rapidly drawing to a close. This crisis, which is finally beginning to receive the attention it deserves, is global in nature and shows signs of becoming extremely critical by the end of this decade.

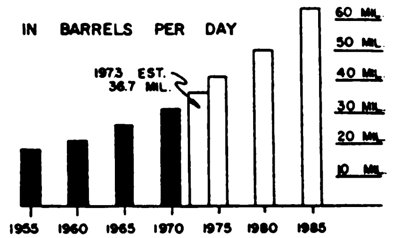
The Dilemma

Although it contains only six percent of the world's population, the United States consumes approximately one-third of its energy. If the nation's demand for all sources of energy—petroleum, natural gas, coal, water, and nuclear power —were converted to equivalent barrels of oil, it would exceed 36 million barrels per day. Experts predict that this demand will almost double between 1973 and 1985 (see Figure 1). Domestic reserves of oil and gas appear to be grossly inadequate to accommodate the projected demand and the much-vaunted nuclear power program has been severely blunted by financial difficulties and environmental delays.

So vast are the quantities involved in the U.S. energy demand that even Alaska's heralded North Slope discoveries promise to do little more than delay the difficulty a few years—if and when they are finally placed on-stream. Of the 1.6 billion equivalent tons of energy burned in 1970, 78 percent was supplied by oil and gas. Most energy predictions indicate this demand will increase to 2.5 billion tons by 1980; Shell Oil further estimates that oil and gas will still have to supply 72 percent of the country's power in 1980.[16] Because of their dominant position and the implications their movement might have on the maritime transportation field, this paper will be limited to a discussion of the oil and gas segment of the energy supply.

FIGURE 1

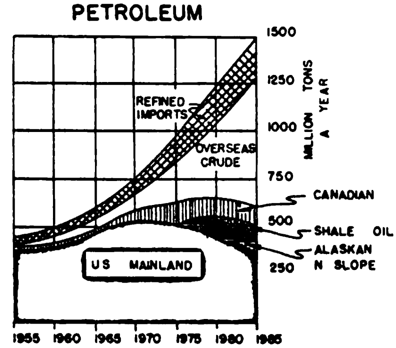
U.S. DEMAND FOR ALL SOURCES OF ENERGY



SOURCE: CHASE MANHATTAN BANK

Professor of Civil Engineering, North Carolina State University, Raleigh, North Carolina, U.S.A.

FIGURE 2
PREDICTED SOURCES OF U. S. PETROLEUM



SOURCE: THE LONDON FINANCIAL TIMES, MAY 28, 1972

The U.S. consumed over 16 million barrels per day of oil in 1972.[16] By 1980 it will need between 20 and 25 million bbls., but U.S. production is expected to rise little from its present level of 11 million.[1] As indicated in Figure 2, there is a growing supply gap which the United States must satisfy from imports or other sources.

Alternative Solutions

The growing dependence of the United States on imported petroleum, particularly from Africa and the Middle East, presents a serious challenge to those responsible for devising a policy for coping with the energy crisis. There appear to be a number of alternative actions, each of which has its disadvantages, that might narrow the anticipated gap between U.S. supply and demand by 1985. Among them are the following:

(1) **Continue the present policy.** At this writing, U.S. policy is one of raising oil import quotas just enough to satisfy fuel demands that exceed domestic production. Theoretically, the quota system protects domestic production and prices and encourages exploration for new fields. Should present policies be continued for the next decade, imports presumably will account for a growing percentage of the demand. This, many oilmen agree, would lead to a serious balance of payments problem approaching $15 billion per year by 1980.[4] Heavy dependence on imports also presents certain obvious national security risks.

(2) **Develop alternative sources of energy.** There is little doubt that all nations should be seeking new sources of energy and this search might well be a cooperative one. Candidate sources include oil shale, nuclear power, and synthetic oil and gas from coal. However, a massive effort would be needed to develop a substantial output and to overcome financial and technological problems if we hope to reduce our dependence on oil even as early as 1985.

(3) **Reduce energy consumption.** Various program with the objective of reducing energy consumption have been proposed: increase fuel prices, switch to smaller cars, tax high horsepower cars, offer graduated rates for electricity, or even ration fuel. Each of them holds some promise for temporary alleviation of the problem but they are politically volatile and probably would not materially relieve the overall situation.

(4) **Increase the domestic supply.** There seems to be general agreement that substantial reserves of hydrocarbons are still to be discovered or produced in the United States. Also, there exists a consensus that unless significant, immediate changes are made in exploration efforts, domestic production of oil will remain at essentially the same level until the early 1980's.[1] More promising are the potential oil and gas reserves of Alaska and the Canadian Arctic. Assuming that the environmental objections to the Alaska pipeline can be resolved in the near future, construction of the pipeline from Prudhoe Bay to Valdez will initially supply only 600,000 barrels per day.[5] However, the field has a production capability estimated at two million barrels per day and could supply this amount by some combination of tankers and pipelines.

Increase imports from other areas. Table 1 summarizes world oil reserves and production as of January 1, 1973. Because of the global demand for fuel, exploration for oil is a continuous process. New discoveries are reported periodically and one might wonder why the U.S. does not simply turn to some of the promising new fields in Africa, Latin America, Indonesia, or the North Sea for its deficit. Unfortunately, demand in the rest of the world, particularly the industrial nations of Western Europe and Japan, is increasing even more dramatically than in the United States (see Table 2). Even regions such as Latin America which have traditionally been major exporters of petroleum are witnessing increasing internal consumption that may limit exports by 1985 to lower levels than at present. Thus, it appears that continued dependence on Middle East supplies by many of the consuming nations will most certainly remain a reality for the near-term future.

An Interim Proposal

None of the alternatives just described are especially attractive. Each has its serious limitations and most do not really offer a viable solution to the energy crisis within the next decade. Two or

TABLE 1
Summary of World Oil Reserves and Production — January 1, 1973

Region	Reserves: Oil bill. bbls.	Reserves: Gas trill. ft.	Oil Production 1972 mill. b/day	No. of Refineries
Asia-Pacific	14.9	101.2	1.81	101
Europe	12.1	178.4	.37	159
Middle East	355.9	344.2	17.19	29
Africa	106.4	189.0	5.67	34
W. Hemisphere	79.6	405.7	15.75	378
(U. S.)	(36.8)	(271.5)	(9.50)	(247)
Total Free World	568.8	1,218.4	40.79	701
Communist World	98.0	664.4	8.91	—
Total World	666.9	1,882.9	49.70	—

Source: Oil and Gas Journal, December 25, 1972.

more of the alternatives in combination might defer the problem a few years but only if critical decisions are made now.

Beyond 1985 there is certainly hope for the development of abundant, cheap, and clean energy sources other than gas and oil. Among the technologies considered are nuclear fission, geothermal energy, solar energy, and oil shale. All of these merit serious consideration but it is not anticipated that they can materially reduce the dependence on oil and gas prior to 1985. Consequently, all subsequent discussion will concentrate on the ensuing period from 1973 to 1985.

TABLE 2
World Oil Surplus or Shortage (mill. bbls. per day)

Region	1970	1975	1980
U.S.A.	— 3.1	— 7.9	—11.5
Canada	0	+ 0.2	+ 1.1
Caribbean & Mexico	+ 3.0	+ 2.4	+ 1.7
Other South America	— 0.5	— 0.3	— 0.4
W. Hemisphere	— 0.6	— 5.6	— 9.1
W. Europe	—12.3	—16.4	—21.0
Africa	+ 5.4	+ 6.7	+ 8.1
Japan	— 4.0	— 7.0	—10.5
Southeast Asia	— 0.2	+ 0.3	+ 0.3
Middle East	+12.8	+24.1	+35.3
Communist World	+ 1.0	+ 0.7	+ 1.0
Other Asia & Oceania	— 0.7	— 1.0	— 1.6
Stock Change & Other Use	— 1.4	— 1.8	— 2.5
World	0	0	0

Source: Sun Oil Company "Analysis of World Tank Ship Fleet," August, 1972.

It is proposed that the United States pursue a short-term policy (1973-78) that would decrease the rate of growth in our consumption of energy while bringing the Alaskan North Slope production on line. In the meantime, we should take steps to meet the anticipated energy needs of 1978-85 by agreeing that the most rational approach is to increase drastically our imports of petroleum and natural gas. This strategy should be actively pursued by constructing a modern fleet of supertankers and liquefied natural gas (LNG) carriers and by planning and developing a system of offshore superports to accommodate them.

Supertankers and LNG Carriers

In dealing with the crisis, the starting point must be recognition not only that the U.S. needs vast quantities of gas and oil but that fuel is going to cost more. Adapting to the changing fuel situation will be a painful process that may be accompanied by traumatic changes in the role of the automobile in American life. Various forecasts suggest that 35 to 50 percent of U.S. energy needs in the next decade will have to be imported. Just where the fuel will come from, in what form, and in what size ships is the subject of much speculation.

Estimates of Required Shipping Capacity

Of the 3.4 million barrels a day of oil imported in 1970, 2.6 million arrived from overseas by tanker and the remainder came from Canada. Because the annual capacity of a tanker varies with its size and voyage length, it is difficult to determine the exact number of ships required. A Chase Manhattan Bank report[8] which expresses needs in terms of tankers of 70,000 deadweight tons (dwt) capacity estimates that 111 such ships would have been needed to handle imports in 1970. By 1975 this number will have increased to at least 500. The report further estimates that "between 1970 and 1985 United States imports of crude oil and refined products will require that at least 43 million tons of new tanker capacity be provided." These estimates do not include 60 new American flag tankers (70,000 dwt.) that will be required to move Alaskan oil from the pipeline terminal at Valdez to the U.S. Pacific coast. Also, they do not take into account any new ships required to replace obsolete ones and, of course, do not reflect the new tankers required to move oil throughout the rest of the free world.

The other major response to the energy crisis is expected to come in the form of natural gas. Because of dwindling supplies at home, gas utilities are turning to Algeria, Libya, Indonesia, and even the Soviet Union for long-term gas supplies.

A completely new oceangoing transportation system will be needed to transport this gas in liquefied form to U.S. ports where it must be stored, then revaporized for consumption. LNG is natural gas cooled to minus 260 degrees Fahrenheit in order to reduce the volume about 620 times. It can then be transported in specially designed LNG tankers.

By 1985 demand for natural gas is predicted to climb to 107 billion cubic feet per day, 35 to 45 billion more than the U.S. will be capable of producing.[24,17] The nation then is expected to import at least 6.5 billion cubic feet per day of liquefied natural gas. According to Federal Power Commission estimates, more than 100 LNG tankers, each of 125 cubic meters capacity and costing about $90 million, may be required to fill U.S. gas import needs by 1985.[19,22] Japan's Kawasaki Heavy Industries foresees the need for 200 LNG carriers by 1990, 100 in trade with the United States, 70 with Japan, 30 with Europe.[10]

Clearly the energy shortage is building up a tremendous market for the world's shipyards—both for oil and LNG tankers. Late in 1972 the U.S. Maritime Administration approved the first of a series of federally subsidized contracts for LNG tankers to be built in U.S. shipyards. Three of the new vessels will be built by the Newport News Shipbuilding and Drydock Co. and three by the General Dynamics Corporation. Several other major shipbuilders are tooling up for possible LNG tanker construction. Because the ships will be used to alleviate the energy crisis, it is politically desirable to involve U.S. finance and shipyards and it is fortuitous that interest in LNG tankers is coming when work levels in American shipyards are picking up. An increasing work force plus reasonable expectation of a construction subsidy for LNG vessels places the much-maligned U.S. shipbuilding industry in a strong position to compete with yards around the world.

The technology of shipping liquid gas by ocean vessel is of American origin and development has already reached the point where a dozen large LNG tankers with a combined cargo lift close to 2.5 million cubic meters are in service, under construction, or on order.[19,3] At present there are several principal sea routes over which LNG moves:

1) Algerian and Libyan gas moves to continental Europe, Great Britain, and in relatively small quantities, to eastern U.S. ports.

2) Gas from Alaska, Brunei, and Abu Dhabi moves principally to Japan.

3) If a recently proposed investment agreement for the sale of Soviet natural gas to the U.S. is consummated, LNG tankers will eventually operate from Murmansk to East Coast U.S. ports. This gas would first move 1,500 miles by pipeline from western Siberia. The three sponsoring companies expect to import two billion cubic feet a day into the U.S.

Economies of Scale

A 1971 U.S. Maritime Administration study[7] projected the following trend in worldwide bulk tonnage:

Date	No. of vessels in the 100,000-200,000 dwt. range	No. of vessels exceeding 200,000 dwt.
1967	30	75
1970	130	180
1975	300	700

Another source of world tanker statistics, the annual Sun Oil Company report, indicates that the world tankship fleet at the end of 1971 totaled 191,748,000 tons and predicts a minimum annual increase of 20 million dwt. from 1971 through 1980.[21] These data suggest a fast-growing international need for larger ships and a spectacular worldwide maritime growth. To meet this need on an economical basis, the use of superships is imperative. A supertanker is usually described as a ship of 100,000 dwt. or larger. There are about 400 now in operation and an additional 300 under construction. The world's largest ship, the 483,000 dwt. Globtik Tokyo, was launched in 1972 by Japan's Ishikawajima-Harima Heavy Industries (IHI). Two more of similar size will be constructed by IHI and two 530,000 dwt. tankers have recently been ordered from a French shipyard by Shell Oil Company to operate on the Persian Gulf to LeHavre run. There is general agreement that vessels in the 650,000-800,000 dwt. range will soon be a reality and the existence of drydocks of one million tons capacity in Japan indicates the possibility of a megaton tanker in the foreseeable future.

TABLE 3
Relative Dimensions of Supertankers

Deadweight (tons)	Length (ft.)	Beam (ft.)	Loaded Draft (ft.)
200,000	1,050	153	62
250,000	1,100	171	66
320,000	1,165	185	72
370,000	1,220	195	76
500,000	1,300	210	85
1,000,000	1,400	245	100

Source: R. Loire, "New Concepts in Superports," **Oceanology, February, 1972.**

Problems of Size

The tremendous growth in the size of today's superships, particularly tankers, has created monumental problems in the design and construction of the ports and terminals needed to accommodate them. Dimensions of existing and proposed supertankers indicate that the loaded draft of vessels in the 250,000-500,000 dwt. range will vary from 66 to 85 feet (see Table 3). A 15 percent increase is usually assumed in order to determine water depth in the approach channels and at the terminal site. Thus, depths in the 100-130 foot-range may be needed.

There are numerous harbors in the world deep enough to handle 200,000 dwt. tankers (Table 4), but none are in the United States. With the exception of Seattle and Long Beach, the maximum maintained channel or entrance depth is 45 feet. Thus, we have the situation throughout most of the world, but particularly in the U.S., that the very bigness of the superships which provides their inherent cost advantages through economies of scale also seriously curtails their choice of ports and routes.

OFFSHORE SUPERPORTS

If this were an isolated problem or one that did not threaten to become more serious, it could be agreed that environmental concerns dictate that the United States simply accept the status quo, maintain the current posture of our port system, and let other maritime nations wrestle with the problem. Such, however, is not the case.

Economic and Environmental Considerations

The principal concern in this paper is to explore the possibilities of providing port facilities that will accommodate the deeper draft supertankers. The very large crude carriers (VLCC's) of 250,000 dwt. can reduce transportation costs by one-third compared with the 60,000 dwt. tankers that now berth in U.S. ports.[20] To accommodate them a whole new approach to designing the deep water terminals to handle deeper draft supertankers must be found.

The cost for dredging existing ship channels into U.S. ports would be astronomical, and it is generally agreed by shippers and port authorities that the best solution is to go offshore and build supership terminals where water depth exceeds 20 fathoms. Except for the United States, every country consuming or producing bulk raw materials in quantity has developed, or is in the process of developing, port facilities for superships.

TABLE 4
Selected Channel Depths

Location	Existing Depth (ft.)
FOS, France	115
Bantry Bay, Ireland	80
Le Havre	70
Rotterdam	70
Long Beach	62
Houston	40

Sources: Industrial Economics Research Division, Texas A & M University, College Station, Texas. Arthur D. Little, Inc.

Currently, more than 50 deepwater port facilities that can accommodate 200,000 dwt. and larger vessels are in operation, under construction, or planned in various foreign countries.[13] The United States is the only major industrial nation without ports capable of handling superships. Its position is not an envious one since it faces the consequences of loss of trade which would erode the already precarious position of its merchant fleet, increased costs of importing raw materials, and greater deficits in its balance of payments.

Major objections to offshore terminals seem to emanate from environmentalists who contend that the likelihood of oil spills and resulting pollution would be increased. The specter of a 325,000 dwt. vessel breaking up in the open sea is indeed cause for trepidation, and somehow the public views it as a greater pollution threat than ten 32,500 dwt. tankers operating in congested waters. Because they would be fewer in number and would operate away from the shipping lanes, superships would probably be less subject to collision. Actually, one could advance a strong argument for the reduction of oil spills by encouraging VLCC's to dock at offshore facilities instead of allowing a number of small tankers to enter existing ports.

Considering the eastern seaboard of the U.S. as an example, it is well known that over 90 percent of the refining capacity of the East Coast is concentrated in the New York and Philadelphia areas. If estimated petroleum needs in 1985 continue to be hauled in average size tankers serving these ports today (30,000 dwt.), about 21,000 tanker calls per year would be needed.[11] At best this could be reduced to 8,400 calls by using the maximum size vessel (75,000 dwt.) that could possibly negotiate the harbors. According to R. W. MacDonald, Planning Manager of the Exxon Company, these calls represent about eleven 75,000 dwt. tankers entering New York harbor every week just to supply the three existing refineries on the Arthur Kill.[11] An offshore terminal in the area that could accommodate 325,000 dwt. tankers, he feels, would reduce the ship arrivals to two or three each week and these, of course, would not have to enter the congested port area. Since most collisions occur in restricted harbors and channels, it is reasoned that they will be materially reduced if the VLCC's deliver their crude oil to a deepwater terminal readily accessible from the open sea.

Review of Existing Facilities

Finding harbors with adequate depths for large ships is not a new problem. In the Western Hemisphere oil companies have been using Canada and islands in the Atlantic and Caribbean as transshipment ports where crude oil and refined products can be transferred from supertankers to smaller tankers that can berth in U.S. east coast ports. In fact, the use of offshore terminals and refineries is almost a modus operandi for American petroleum imports. Gulf Oil uses a 100-foot harbor at Point Tupper, Nova Scotia; Hess has plants in the Virgin Islands and Newfoundland; Standard Oil of California has terminals at St. John, New Brunswick and Freeport, Bahamas; and Texaco is in Trinidad. Additional terminals are being developed or planned in Haiti, Puerto Rico, and the Netherlands Antilles.

Offshore terminal facilities are a well established part of the petroleum transport system in Europe and the Middle East. Such facilities have existed in the Persian Gulf for many years and Gulf Oil's Bantry Bay operation in Ireland represented an early commitment to large tankers that could not enter existing harbors in Northern Europe. More recently, a huge new oil port complex has been launched in the Shetland Islands. Scheduled to begin operation in 1976, it will include storage facilities and berths to accommodate several 250,000 dwt. tankers. At Le Havre, France, a new superport that can accommodate 500,000 dwt. vessels is under construction and scheduled for completion in 1975.

Perhaps the most ambitious project of all is the world's largest offshore oil-unloading terminal now under construction in Kagoshima, Japan. When completed, this berth, which is 1300 feet offshore in 112 feet of water, will be able to accommodate the three previously-mentioned 483,000 dwt. Globtik tankers that will transport Middle East oil to Japan.[9]

If these investments are not sufficient proof of current activities in international energy supply, a recent announcement by Burmah Oil Company, Ltd. of London would seem to lend further credence to the offshore-terminal concept. Burmah is proposing to construct in American shipyards six new 380,000 dwt. tankers—each of which is almost three times as large as any American-flag vessel in operation today. If they are built, they could not be accommodated at any continental U.S. port. Instead, they would haul crude oil from overseas supply areas to a new transshipment facility in the Bahama Islands for ultimate distribution to U.S. ports by smaller tankers. The Bahama transshipment facility, which can be expanded to 150-million barrel capacity, is expected to be ready for use late in 1974.[14] As part of Burmah's total response to the energy gap, it plans to operate, in conjunction with its terminal on Grand Bahama Island, a dozen 350,000-400,000 dwt. supertankers, another dozen 80,000 dwt. feeder ships, and nine LNG vessels.[6]

Present Status of U.S. Offshore Development

Two significant studies, which addressed themselves to the problems of offshore terminals, were recently made public in the United States. Because of their importance, the findings and conclusions of each report as they relate to the need for offshore facilities are briefly summarized in the following sections:

1) Released by the U.S. Maritime Administration in 1972, this study of offshore terminal systems concepts[20] was performed by the firm of Soros Associates, Inc. Among the pertinent findings:

a. Most of the future U.S. oil imports are expected to come from the Persian Gulf and North Africa.

b. Shipping costs for importing Middle East oil into eastern U.S. ports can be reduced from $9.63 to $6.15 per ton by using 326,000 dwt. tankers instead of 65,000 dwt. vessels.

c. Two types of marine terminals

should be developed: intermediate and deep draft terminals. The intermediate type would be built in protected waters to serve vessels up to 250,000 dwt. and would generally be used for Caribbean petroleum imports, LNG imports, and dry bulk commodities. The deep-draft terminals (90 to 100-ft. depths), to be constructed in both protected and unprotected water, would receive the longer-haul Persian Gulf imports in tankers up to 350,000 dwt.

d. Serious consideration should be given to accommodating the 500,000 dwt. vessels presently being planned for service in Persian Gulf and European terminals.

2) Released by the U.S. Army Corps of Engineers in 1972, a study performed by the consulting firm of Robert R. Nathan Associates[18] urged adoption of policies for "Planning, design, and control of development and operation of deepwater ports and related activities in the public interest." The Nathan report indicated that dredging to deepen existing channels "would pose major economic and environmental issues" and that "the most practicable petroleum deepwater port alternatives are generally offshore facilities."

Both reports made specific recommendations as to location of offshore facilities. The Soros report said that "the most urgent need is for importing oil into the North Atlantic Region" with similar facilities needed next on the Pacific Coast and on the Gulf Coast. Thirty-two potential sites were identified and a terminal location outside of Delaware Bay was selected as the site that would best satisfy the needs of the North Atlantic region while minimizing environmental problems. The Nathan report issued somewhat similar conclusions, saying the most feasible plan was to build a single large port 13 miles off Long Branch, New Jersey or two smaller ports—one off Long Branch and the other off Cape Henlopen, Delaware. Public and private interests in Texas and Louisiana have also been actively pursuing offshore ports for several years. The Texas State Legislature has created a commission to design such a facility and consortia of oil companies in each state are planning ports off Freeport, Texas and near the mouth of the Mississippi River.

It is only fair to state that these proposals have precipitated heated counterattacks, primarily from those concerned about environmental damage. Most Atlantic and Gulf Coast states do not possess adequate harbor depths to handle the supertankers described herein, but the two that do, Maine and Delaware, have already taken steps or are contemplating legislation that would prohibit deepwater facilities within their harbors or jurisdictional limits. In 1971 Delaware passed a conservation law forbidding any more heavy industry on its shoreline; the Maine legislature is considering a bill that, among other things, would ban the establishment of deepwater oil ports anywhere in the state except Portland, a port already operating at capacity.[23]

Just where do we go from here? Based upon the arguments contained in preceding sections, the author believes that we have no choice but to seek the solution at sea. Whether it be funded by federal or private sources or some combination of the two, it appears imperative that the United States begin immediately to plan and construct a system of offshore superports where water depth exceeds 20 fathoms. Controversy exists as to whether they should be designed to handle only liquid bulk commodities or dry bulk such as coal, grain, and ores as well. It is believed that it would be best, at least initially, not to accommodate both at the offshore terminals; therefore, a facility to handle only liquid bulk commodities—e.g., crude oil, refined petroleum products, and liquefied natural gas—is recommended. Further, it is strongly recommended that at least two offshore terminals, one to serve the major energy market in the North Atlantic Region and one to serve the petrochemical industry along the Texas-Louisiana Gulf Coast, be simultaneously developed as part of a total maritime system plan. Instead of independently planning port facilities to respond to vessel size, or as has too often been the case, designing vessels to satisfy port limitations, why not consider the needs and limitations of each and optimize the entire system?

While the details of design and even the selection of the type of offshore terminal—single buoy mooring system, artificial island, floating dock, etc.—are beyond the scope of this paper, they too should be an integral part of the total planning process. The energy crisis and the growing world fleet of supertankers are very real problems. The United States is in a truly unique position to effect a solution. It can opt to appease the environmentalists, in which case no ports will be built and the oil and gas will have to be transshipped from Canada or the Caribbean, or it can take advantage of experience gained with offshore facilities in the rest of the world and develop a network of safe, environmentally-acceptable offshore terminals and concomitant ship and pipeline systems. The challenge is a formidable one; the consequences of failing to act soon are almost overwhelming.

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