STRENGTHENING GLOBAL ENERGY SECURITY THROUGH ALTERNATIVE INTERNATIONAL PETROLEUM STORAGE AND LOADING TERMINALS OUTSIDE THE STRAIT OF HORMUZ

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Life in the 21st Century is highly dependent on commercially accessible sources of energy. The full spectrum of living from socio-economic development, research and scientific breakthroughs to modern lifestyles owes to the human ability to harness greater and better forms of energy. Quest for energy has in itself become a driver of economic and industrial development. Energy is at the heart of modern-day prosperity and concerns for stability and security of energy supply have become important aspects of international diplomacy. Hydrocarbons (oil and natural gas) have been the principal sources of commercial energy during the last century. But these natural resources are non-renewable and are fast depleting. It is generally anticipated that there is likely to be a major change in the global commercial energy mix toward the middle of this century. This realization of the impending decline in oil is spawning an energy crisis that, if not collectively addressed, could affect global prosperity and even jeopardize the global peace.

This paper briefly relates to one aspect of the energy crisis i.e. global oil movement. It spotlights the concentration of huge global reserves of oil and natural gas in a small region of the Persian Gulf countries. It looks at the contribution of the region to the global oil trade and highlights that the Strait of Hormuz has already become the most critical choke-point to the international shipping. Figure-1 shows a map of the Persian Gulf region extending to and including the countries in South Asia, South East Asia, Far East the Asia Pacific that are supplied oil by the east-bound routes.

Figure - 1

The paper projects the expected growth in oil exports from the region in view of the dwindling wide-spread availability of oil in other parts of the world and consequently increasing dependence on the outlasting reserves of the Persian Gulf countries. It identifies the limitation of the Strait of Hormuz to cope with the anticipated escalation in oil movement and suggests ways to augment the capacity through an option of alternative petroleum storage and loading terminals outside the Strait.

The newly completed Gawadar deep-sea port offers one such option. It is well-located outside the Gulf of Oman in the Arabian Sea on the maritime route of the east-bound oil. The port can handle super tankers that form the mainstay of the global oil movement. This enables Pakistan to play a substantive role in strengthening the global energy security as well as peace. The paper only introduces the subject in concept and concludes with a recommendation of some follow-up work in the form of focussed studies. The statistical information used in the paper is for the year 2005. The figures are adopted from a variety of literature openly accessible to public and are used with open acknowledgement. In the common international references the Gulf is interchangeably referred to as Arabian or

Persian and it is intended to stay clear of any underlying sensitivity of the name.

Concentration of Global Reserves of Oil and Gas in Persian Gulf Region

Oil is the predominant source of commercial energy in the world. It makes up for about 38% of the global primary energy (commercial) mix. Around 85 million barrels of oil is presently consumed in the world everyday. The consumption of oil is expected to grow by about 2.0% every year well into the middle of this Century. Figure-2 shows the demand for commercial sources of primary energy from 1970 to-date and projects the yearly demand up to 2030.

World Primary Energy Demand

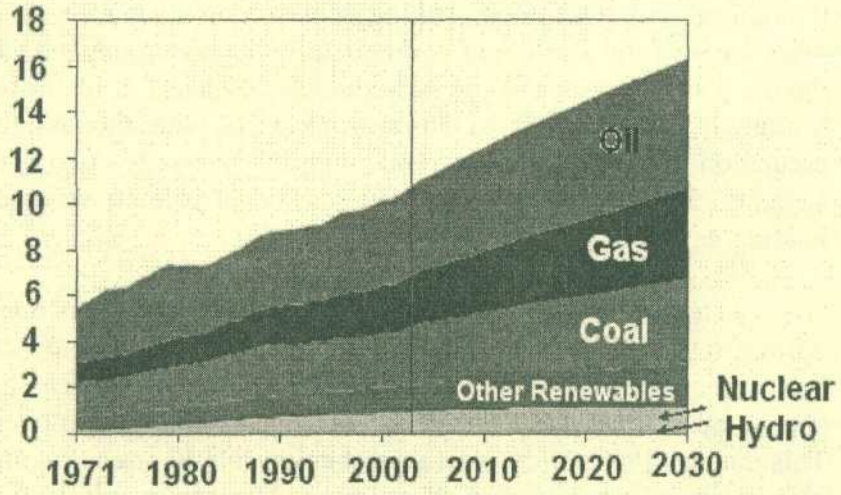


Figure - 2

Nearly 70% of the worldwide oil supply, around 60 million barrels per day, is imported, which represents the scale of the global oil trade. Presently oil is widely available and the maritime routes are able to handle the required shipping flows. The widespread availability of oil is however shrinking due to declining reserves and

a number of oil surplus/exporting countries (like China, Malaysia and Indonesia) have/would become net importers of oil in the coming years.

Over half of the global reserves of oil (56.5 %) are concentrated primarily in a few countries of the Persian Gulf (Iran, Iraq, Kuwait, Saudi Arabia, UAE and Qatar), which are likely to outlast many other sources of the world oil supply. It is, therefore, generally anticipated that the global reliance on the oil reserves of the Persian Gulf countries will continue to increase in the foreseeable future. Figure-3 shows a map of the Persian Gulf, the oil producing countries, the Gulf of Oman and the Strait of Hormuz that connects the adjoining bodies of water.

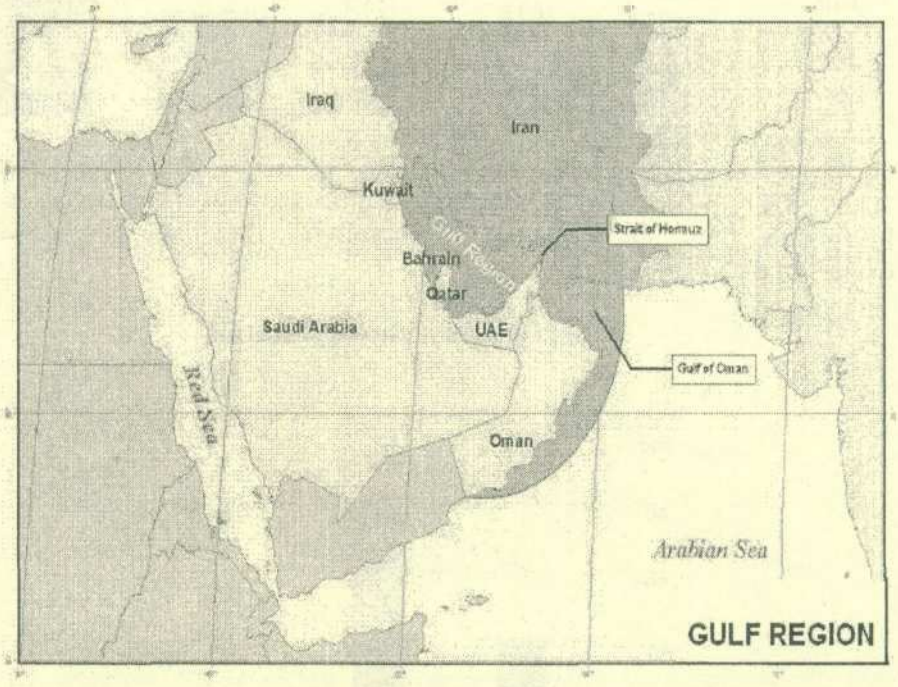


Figure - 3

Figure-4 shows the share of proved reserves of oil for various regions of the world. Out of 1200 billion barrels global reserves 684 billion exist in the Persian Gulf region alone.

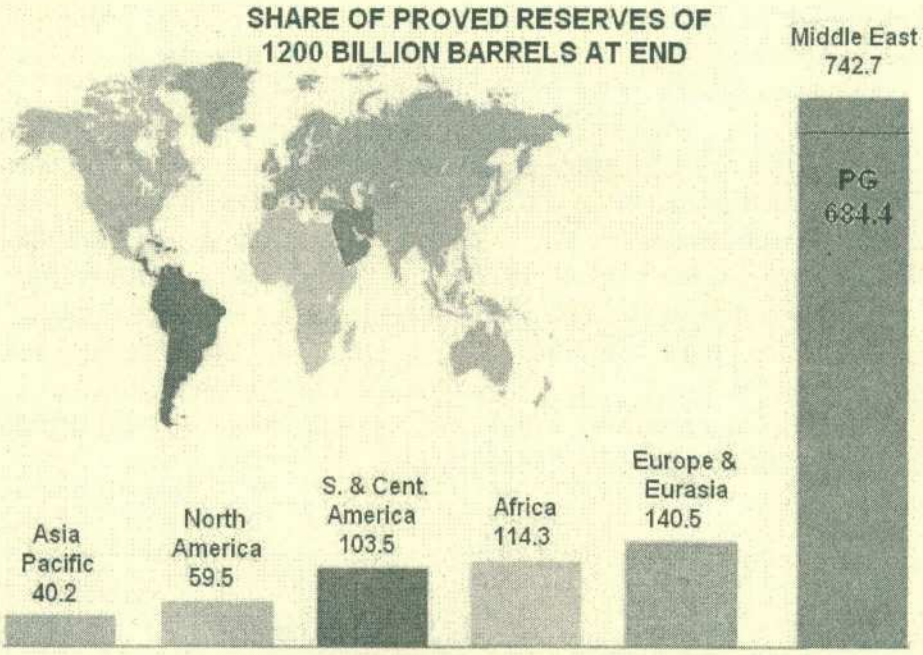
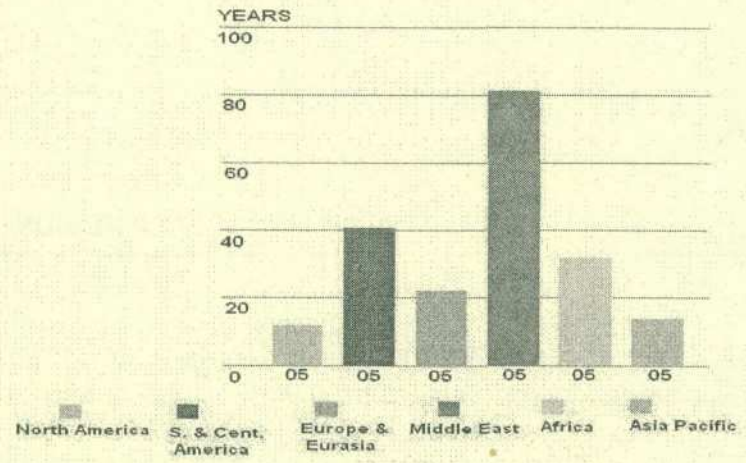


Figure-4

Figure-5 shows the relative period in years of the reserves to production ratio: the Persian Gulf region has the highest ratio in excess of 80 years.

Reserves-to Production Ratios



The world's oil R/P ratio declined slightly in 2005 to 40.6 years from 40.7 in 2004, although reservescontinued to increase. Iran and Russia accounted for most of the increase. Reserves were 17% higher than the 1995 level; production was 19% higher.

Figure-5

Figure-6 shows the same ratio over the world map: the Persian Gulf countries in general and Iraq in particular stand out for over 100 years of reserves to production ratio.

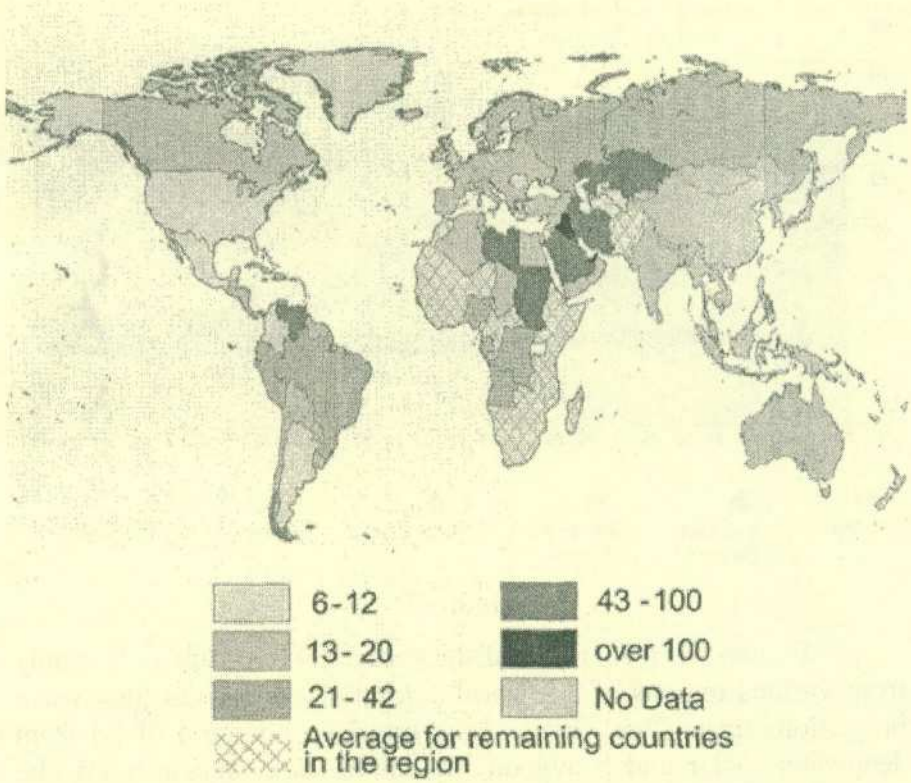


Figure-6

Figure-7 shows the relative production of oil from various regions during the 25 years: around 90% production shown against the Middle East is actually from the Persian Gulf region.

PRODUCTION BY AREA

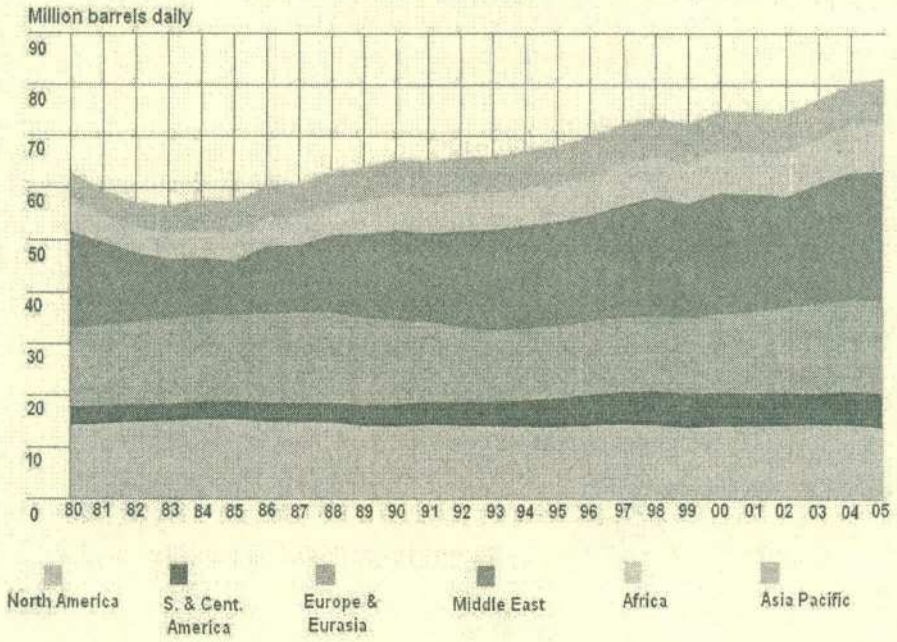


Figure-7

Figure-8 is a snapshot of the year 2004. It shows oil supply from various regions of the world since 1930 and gives long-wave projections up to 2050. Even if the futuristic potential of oil from deepwater, polar and heavy oil sources is taken into account, the proven reserves of the Persian Gulf region will continue to provide substantive share of the global oil supply up to and even beyond 2050.

OIL & GAS LIQUIDS
2004 SCENARIOS (SUPPLY)

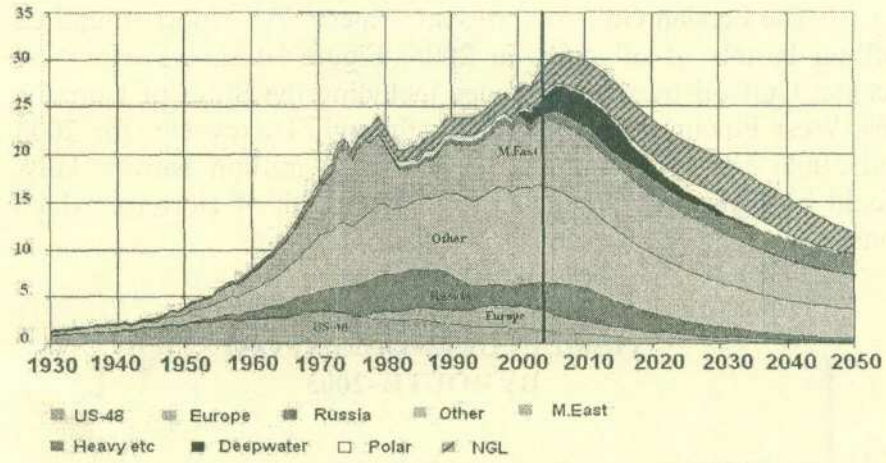


Figure-8

Figure-9 gives a summary of the Persian Gulf oil and gas resources as a percentage of the world covering: crude oil reserves, oil production capacity, excess oil production capacity, oil production and natural gas reserves. It is important to note that as of 2003, all the excess production capacity of oil in the world existed only in the Persian Gulf region. Most or the whole of that excess capacity has been since been brought into production to cope with the unexpected increase in the world oil demand during the last three years.

PERSIAN GULF AS OF PERCENT OF WORLD 2003

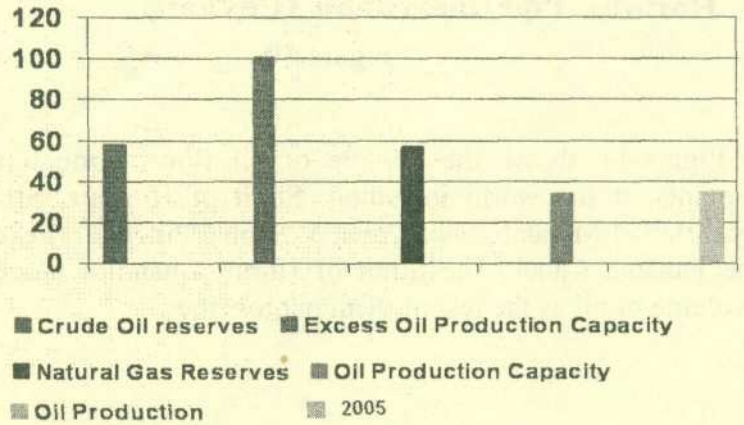


Figure-9

Projected Flow of Oil from Gulf Region

The Persian Gulf countries are expected to export around 22 million barrels of oil daily in 2006. Figure-10 shows export of Persian Gulf oil by various routes including the Strait of Hormuz, East-West Pipeline through Yanbu, through Turkey etc. for 2003 and 2006. Nearly 90% of the exports, 20 million barrels daily, would be transported through the narrow Strait of Hormuz, which constitutes a big choke point for the global oil trade.

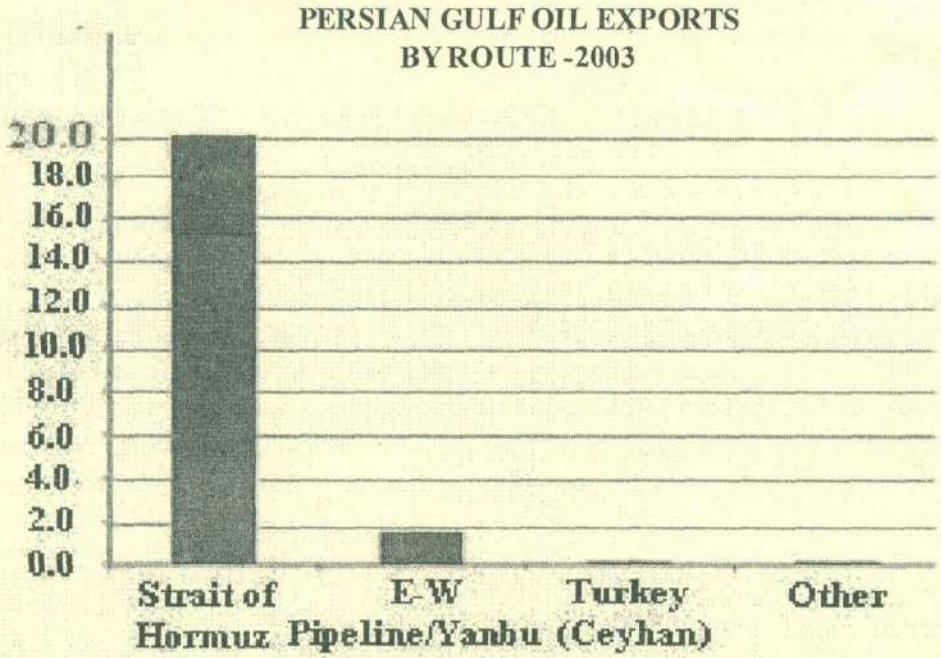
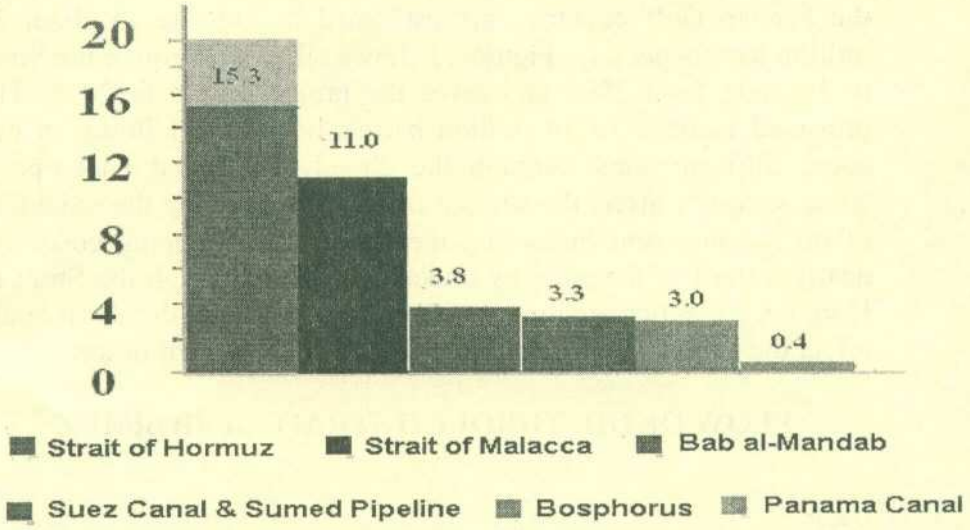


Figure-10

Figure-11 shows the volume of oil flows through major choke-points of the world including: Strait of Hormuz, Strait of Malacca, Bab al-Mandab, Suez Canal & Sumed Pipeline, Bosphorus and the Panama Canal. The Strait of Hormuz handles nearly the same volume of oil as the rest of them put together.

OIL FLOWS, MAJOR CHOKEPOINTS & TRANSITED AT MAJOR STRATEGIC LOCATIONS 2003



Source: Energy Information Administration 2003)

Figure-11

Figure-12 contains a map showing the volumes of oil flows through major choke points and the transit routes round the globe. This readily shows the predominant status of the Persian Gulf oil exports through the Strait of Hormuz.

OIL FLOWS, MAJOR CHOKEPOINTS & TRANSITED AT MAJOR STRATEGIC LOCATIONS 2003

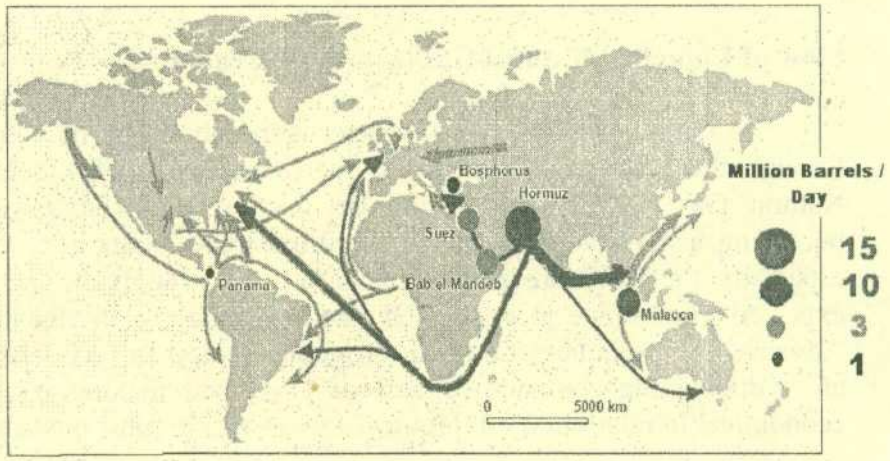


Figure 12

In little over a decade from now, in 2020, oil exports from the Persian Gulf countries are estimated to increase to about 34 million barrels per day: Figure-13 shows oil flows through the Strait of Hormuz from 2000 and gives the projection up to 2030. The projected increase of 14 million barrels of daily oil flows, in just about thirteen years, through the already congested choke-point could seriously affect the smooth flow of oil affecting the reliability of oil supplies and increasing the freight and shipping costs. As nearly a third of the globally traded oil passes through the Strait of Hormuz, the anticipated increase in oil flow through the Strait could affect the global energy security as well as the regional peace.

FLOW OF OIL THROUGH STRAIT OF HORMUZ

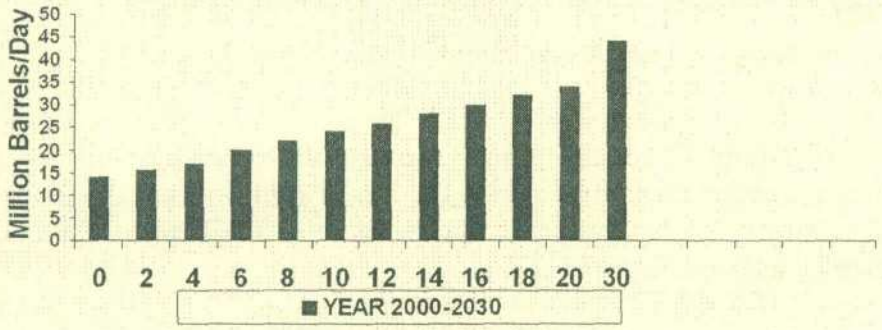


Figure-13

Flow of Liquefied Natural Gas from Gulf Region

Although the focus of this paper is mainly on oil movement through the Strait of Hormuz, the increasing trade of Liquefied Natural Gas (LNG) by specially designed refrigerated ships is becoming a new factor in global maritime trade. Natural gas and especially the LNG are among the fastest growing fuels and are expected to continue to grow well into the middle of the century. Advances in the liquefaction and refrigerated shipping technologies are reducing the comparative cost of LNG and making it quite economical in relation to oil. Figure-14 gives two graphs: one shows

the trend with time of the reduction in the unit cost of LNG plants since 1960 and the second shows the trend of reducing cost as the size of LNG chain increases owing to the advances in technologies and economies of scale. In both cases the cost has reduced by nearly half during the last two decades and the trend displays a steeper decrease in the near future.

LNG CHAIN CAPACITY & COST TRADE-OFF

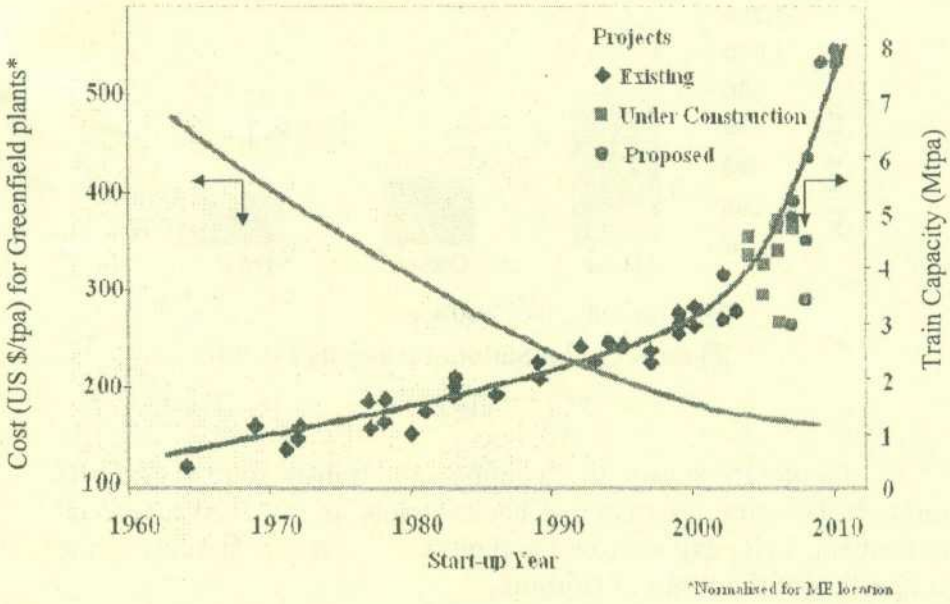


Figure-14

The Persian Gulf countries are very rich in natural gas and nearly 58% of the global gas reserves are located in the region: Iran has the second largest and Qatar the third largest after Russia, which has the largest gas reserves in the world. The gas rich Persian Gulf countries are developing LNG export capacities faster than any other region in the world.

Figure-15 shows the gas liquefaction capacity of Qatar, Oman and UAE for 2003 and its projected increase for 2007: Qatar's capacity is increasing by nearly 40% in only four years. This shows the trend of LNG market: the volume of LNG export from the region is expected to grow even faster.

GAS LIQUEFACTION CAPACITY - 2003

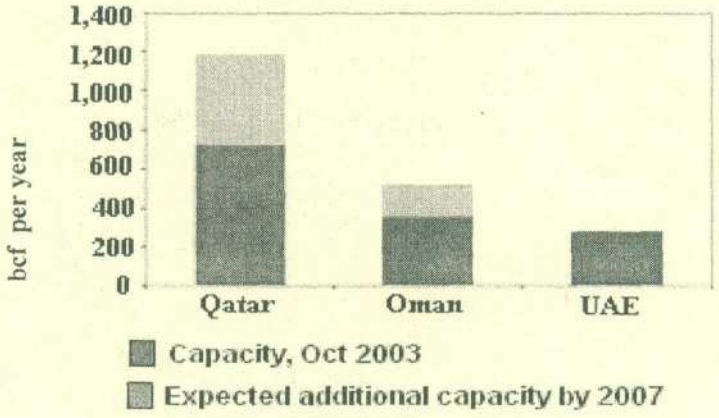


Figure-15

Figure-16 shows the volume and transit routes of LNG through the same international choke-points as involved in the oil movement. LNG export from the region will add substantially to the congestion of the Strait of Hormuz.

INTERNATIONAL SEA-BORNE TRADE – 2003 (BCM)

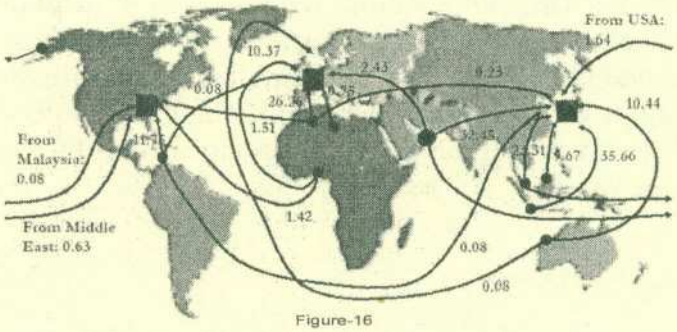


Figure-16

Existing Arrangements of Persian Gulf Oil Export

The presently available arrangements for movement of Persian Gulf oil include the approximately 5-million-bbl/d-capacity East-West Pipeline across Saudi Arabia to the port of Yanbu and the Abqaiq-Yanbu natural gas liquids line across Saudi Arabia to the Red Sea. These options besides being longer and more expensive in transportation costs are very limited in their capacity and are essentially provided as emergency back-up in case of interruption of oil flow through the Strait. There may be a potential of enhancing the capacity of export via the Red Sea, but it would still not meet the requirement besides being longer and expensive as most of the oil fields of the countries are located close to the Persian Gulf which provides the shortest export route. Figure-17 shows a map giving locations of the major oil and gas fields of the region: most of the fields are located either offshore in the Gulf or onshore around the Gulf. The Gulf provides a natural export route but the Strait of Hormuz could limit its export capacity.

Figure-17

Options for Augmenting Export Capacity of Persian Gulf Oil

The petroleum exporting countries of the Persian Gulf could create outlets for additional oil exports outside the Gulf. They could do that by setting up adjunct oil storages and loading terminals

beyond the Strait in the Gulf of Oman and the Arabian Sea. Figure-18 shows a close-up map of the Strait of Hormuz with shaded contours of water depth. Ships can use only the deeper channel providing the required draft which is limited to a width of about six miles.

Figure-18

Figure-18

Figure-19 shows the incoming and outgoing shipping lanes of about two miles width each separated by a middle lane of two miles. The limited number of lanes in the narrow Strait creates the choking effect on the shipping traffic.

Figure-19

The exporting countries could pump the additional oil through sub-sea pipelines to the alternative outlets and augment their export capacities without adding to the congestion of the Strait of Hormuz. Fortunately, there are a number of options for locating adjunct/alternative terminals outside the Strait of Hormuz along the Coast of Iran, Pakistan and Oman. Considering the enormous increase in the volume of oil that would be flowing from Persian Gulf sources from 2020 onwards, all available options would perhaps be required. The new Iranian deep sea port at Chabahar about 150 miles east of the Strait in the Gulf of Oman and new Pakistani deep sea port at Gawadar about 250 miles east of the Strait in the Arabian Sea together with some ports on the Coast of Oman are likely choices. Figure-20 shows a satellite image of the region showing the locations of the ports of Chabahar and Gawadar.

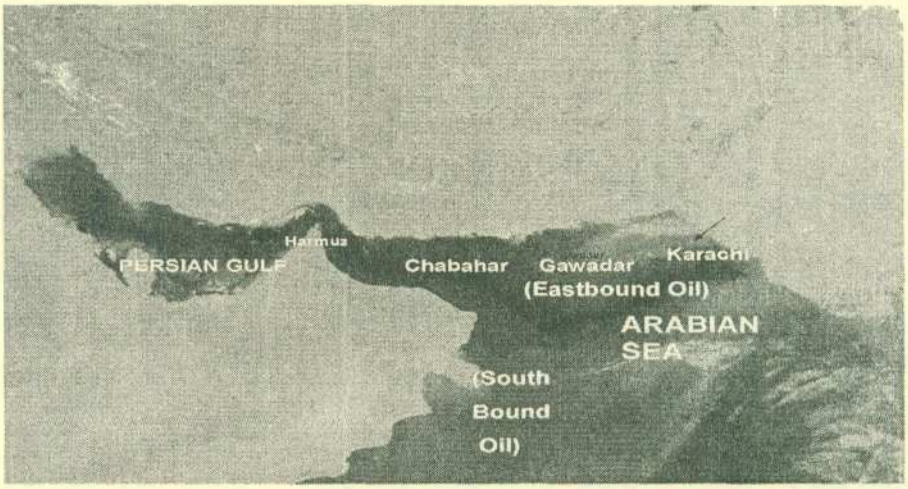


Figure-20

Figure-21 is a map view of the Iranian ports serving the Gulf.

Figure-21

Figure-22 shows the map of the Gulf of Oman and Arabian Sea and Omani ports that could provide a possible option.

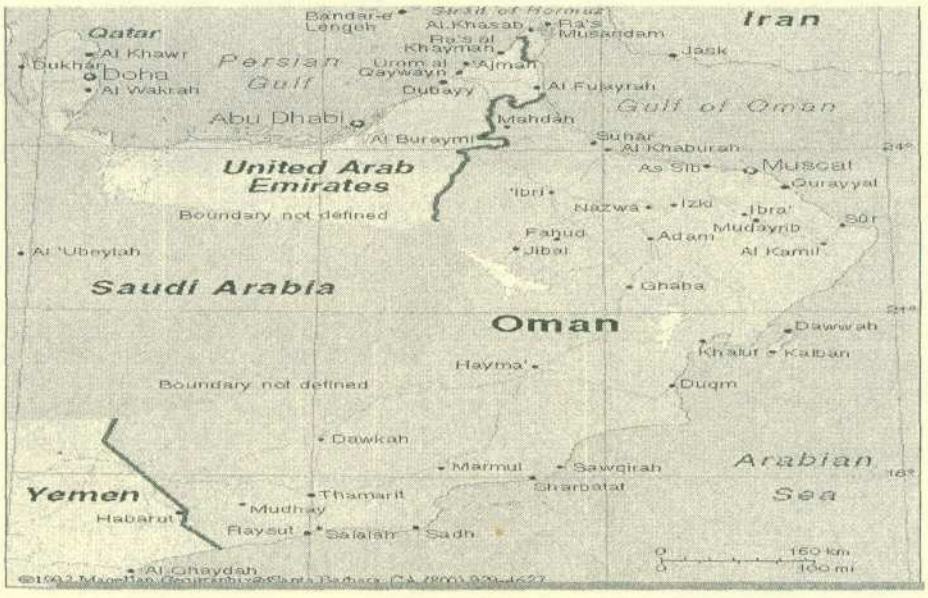


Figure-22

Oman option would be suitable for south bound oil meant for the European and USA markets. The Iranian Chabahar port is suitably located for both South and East bound oil. Figures 23a&b show a map and a satellite close-up view of the new Iranian deep-sea port at Chabahar. The Pakistani port of Gawadar is suitable for east-bound oil for South Asian, South East Asian and Asia Pacific markets predominantly of China, Japan and India.

Chabahar Port

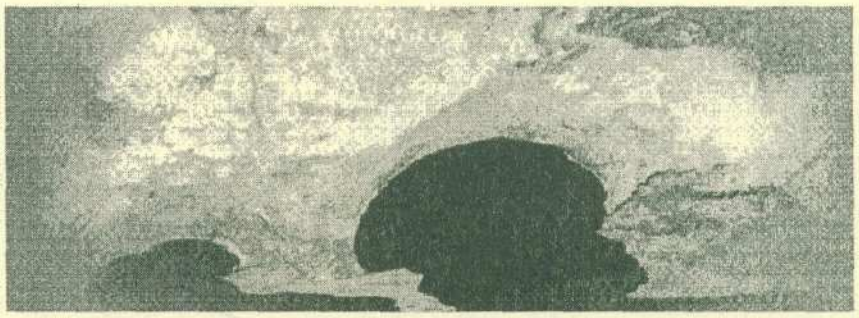


Figure-23a & b

Gawadar Option for Long Term

The proposed outlet at the Gawadar deep sea port could take a part of 10 million barrels daily increase in the east-bound oil from the Persian Gulf countries by 2020. The Gawadar port can handle very large crude containers (VLCC) of up to 0.5 million tons dead

weight which form a crucial part of the international oil movement. Figure-24 shows the schematic layout of the port which has recently been completed and commissioned to operation. Some possible location sites for storage and loading terminals are identified but this has to be in line with the Master Plan of the port development. The increase in the eastbound oil in 2020 is expected to go up to 10 million barrels daily, of which the export to China alone is expected to go up by over 5 million barrels daily. It would appear impracticable to ship the required quantity of oil through the Strait of Hormuz from 2020 onward. Open outlets outside the Strait are likely to become cost-effective and feasible options. It is an appropriate time to give this concept a focussed attention, as it would take over a decade or so for the facilities to be created and oil export arrangements to be operative.

SCHEMATIC LAYOUT OF GAWADAR DEEP SEA PORT

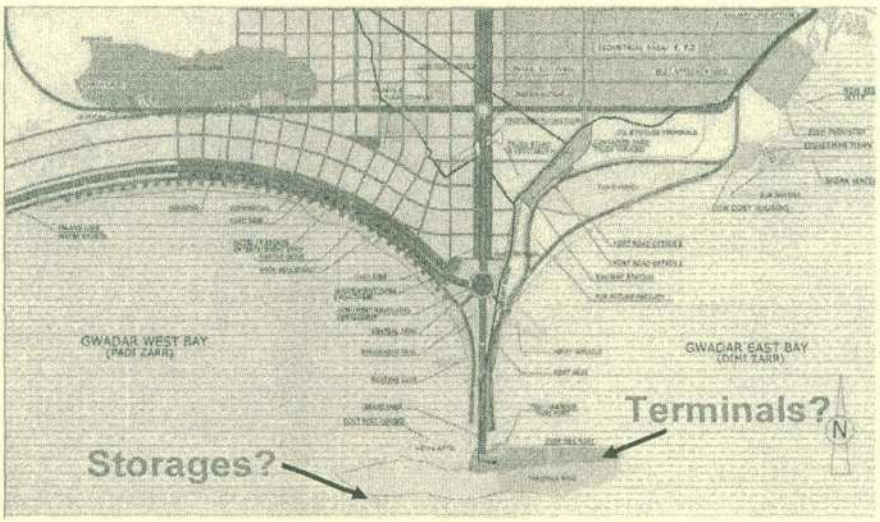


Figure-23a & b

The required infrastructure that comprises exporting country storage facilities, sub-sea pipelines and pumping facilities, outside Hormuz storage facilities and deep-sea loading terminals. Figure-25 gives a rough estimate of time required for completing the infrastructure that spreads over a decade.

TIME SPAN

Activity	Time/Year
Concept Study/International Charter Model	1
Review by PG Oil Exporting Countries	1
Technical & Economic Feasibility Studies	1
Permits/Licenses/Agreements	1
Project Designs	1
Financing Arrangements	2
Construction & Commissioning	3
Earliest Availability	**10**

Table-25

Gawadar Option for Medium Term

It may also be feasible to consider the option of trans-shipment from Gawadar deep-sea port instead of or in addition to the concept of alternative storage/loading terminals. In trans-shipment arrangement oil could be taken out of the Strait of Hormuz by super-tankers and then transferred through single-point mooring floating arrangement directly to smaller vessels for onward shipment. A large number of smaller vessels that carry oil through the Strait presently could thus be reduced. Instead a larger number of super-tankers would ply through the Strait, which would enhance the capacity manifold. The trans-shipment option does not require sub-sea oil pipelines, storages and loading terminals. This option could be very economical as it would cost much less and take much less time to put in place. This could, therefore, be an interim arrangement till such time that the requirement for storages and alternative loading terminals becomes real and commercially feasible.

Suggested Work

The whole concept is based on a visualized scenario of regional oil movement from medium to long term time horizon. It needs more work to bring it into a focus. There is a need to initiate a conceptual study to foresee the increasing quantum of oil trade through the Strait of Hormuz, assess the effects of the expected increase in oil trade on maritime congestion and identify the potential benefits of the proposed outlets at Gawadar to oil exporting and importing countries as well as to Pakistan. A subsequent study could concentrate on the economic aspects for promoting investment on multilateral basis. Besides the promising economic value of the concept, its principal thrust would be on creating a framework for multilateral cooperation to sustain and facilitate global access to the vital sources of energy concentrated in the Persian Gulf region. It may be expedient to launch the concept from the auspices of the United Nations for the required multilateral undertaking.

Conclusion

The prospect of alternative outlets augmenting the export capacity of the Persian Gulf oil would ease potential concerns for the stability and security of oil supplies among the oil importing countries. This will contribute to peace and prosperity of the world in line with the vision and charter of the United Nations. As a vibrant member of the world comity, Pakistan could play a vital role and contribute effectively to global peace and prosperity by opening its infrastructure to world oil movement and strengthening global energy security. Newly commissioned Gawadar deep-sea port is ideally located for alternative petroleum outlets outside the Strait of Hormuz especially for east-bound oil for South Asian, South East Asian, Far Eastern and Asia Pacific markets. As an interim arrangement Gawadar port could provide trans-shipment facilities through a single point mooring floating arrangement by transferring oil from super-tankers directly to the smaller vessels and thereby reducing the large number of the smaller vessels currently congesting the Strait. At a later stage when there is a need the option of alternative storage and loading terminals might become

commercially feasible. The paper suggests additional work in the form of pre-feasibility studies to explore the concept.

Author

Dr. Gulfaraz Ahmed is Honors graduate and Gold Medalist in civil engineering and holds MS and PhD degrees in Petroleum Engineering from Stanford University, USA. He has rich and diverse experience in energy sector policy, planning, operations, management and regulation as Chairman/CEO Oil & Gas Development Company Limited (OGDCL); Chairman National Electric Power Regulatory Authority (NEPRA); Member Nuclear Regulatory Board/Authority; Federal Secretary to the Government of Pakistan in the Ministry of Petroleum & Natural Resources; and Consultant to UNDP on Energy. Dr Gulfaraz Ahmed has authored numerous publications and articles.