ECONOMICS OF PIPELINE TRANSPORTATION

A DISSERTATION REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

MASTER OF BUSINESS ADMINISTRATION (OIL & GAS MANAGEMENT)

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I also place on record my appreciation for the support provided by staff members of library and computer laboratory of the University.

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This is to certify that **Mr. Susheel Kumar** of M.B.A. (Oil & Gas Management) has completed his dissertation titled ***"Economics of Pipeline Transportation"*** under my supervision.

To the best of my knowledge and belief the work is based on the investigation made, data collected and analyzed by him and it has not been submitted in any other University or Institution for award of any degree or diploma.

Date: April 30, 2005

Mr. Sanam Kumar
30/4/05

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EXECUTIVE SUMMARY

Oil and gas pipeline systems are remarkable for their efficiency and low transportation cost. Pipelines are energy efficient, the link between pipeline size and economy is apparent. The relationship between size and capacity is also dramatic. A 36 inch diameter pipeline can carry upto 17times more oil or gas than a 12 inch diameter pipeline, but construction and operating costs do not increase at nearly same ratio.

The report will analyse and establish the benefits of pipeline mode of transportation over other modes like Rail, Road, tankers etc. and would also make comparative study of the current state of development of pipeline infrastructure of our country as compared to the developed countries. As we are one of the fastest growing economies in the world and have the potential to become a developed nation in next 20 years for which infrastructural development in the energy is one of the imperatives. The report will make a techno - economic study that helps in achieving economies of scale in pipeline mode of transportation. The report will also consider weakness and the constraints which are encountered in developing pipeline infrastructure.

INTRODUCTION

A network of sophisticated pipeline system transports oil, natural gas, and petroleum products from producing fields and refinery around the world to consumers in every nation. This network gathers oil and gas from hundreds of thousands of individual wells, including those in some of the world's most remote hostile areas. It distributes a range of products to individuals, residences, businesses, and plants. Pipelines bring oil from Alaska and oil and natural gas from Siberia to global consumers. Pipelines bring oil and gas produced from offshore wells to shore, often through water several hundred feet deep.

The Indian economy is the toast of the world today and if there is one sector that can truly claim to be 'fuelling' its growth, it is the oil and gas sector. Beyond semantics, the oil & gas industry has embraced the winds of change that have swept through it in. Liberalization has implied global competition and the need for constant change and innovation. Commoditization is reducing differentiation, perceived value, price, and profitability. A need to quickly adapt systems to reduce risk and costs; increase visibility and transparency; improve response time, cash flow and productivity; optimize resource utilization and increase profitability. In short, it meant learning to survive and grow simultaneously.

The expected rapid increase in India's energy requirements will lead to a corresponding increase in the quantum of fuel transported across the nation

Necessitating the use of cutting-edge transportation/transmission techniques for the distribution of fuel in a cost-efficient and effective manner. Traditional transportation Networks are - Rail, Road, Sea, India has traditionally relied on the use of rail and barges for the transportation of fuels around the country. The railways currently transport about 40% of India's fuel consumption, with roads and coastal transport accounting for about 18% and 12% respectively. While railways have traditionally been the largest transporter of petroleum products in the country, the share of the railways has been steadily decreasing over the past few years. Over the long run, the cost of transportation through rail increases yearly because of the higher operating cost as against pipelines whose operating costs are minimal and whose cost of servicing capital reduces over time. The freight rates of railways have over time been distorted due to the cross subsidization of passenger traffic by freight traffic. With increased autonomy being given to the railways, the extent of cross subsidy is expected to reduce and railways are expected to serve a significant portion of the transportation requirements of the country, at least in the short and medium term. In 1998-99, 8 mmt of product was transported through coastal tankers. Given that in future, coastal refineries are expected to have captive product jetties for coastal movement of products and all future refineries their own Single Buoy Moorings to import crude, only normal/moderate investments would be required for enhancing port capacity for transportation of petroleum products. Current interest in the traditional transportation networks used for the movement of fuels in India is largely driven by the uncertainty arising out of clear directions on regulations and

tariff fixation for pipeline transport, with several players in the petroleum sector evaluating alternate options for transportation of oil products. Media reports indicate that Reliance is negotiating with the Railways for an attractive freight arrangement against assured volumes. If this arrangement works out, it would bring down Reliance's immediate need for building a trans-India pipeline network. Efficiencies in the road sector, after the GoI's highway development programme have created yet another option for transportation of petroleum products.

Pipelines - The Preferred Mode Of Transportation

In recent years there has been a growing public awareness of global environmental challenges throughout the world. This awareness is fostering a new sense of urgency to protect and preserve the natural environment. Environment management is the art that seeks to balance human demands upon the earth's natural resource base, with the natural environment's ability to meet those demands on a sustainable basis. Improving the quality of life of citizens is the main policy objective of socio-economic development in all countries of the world. The most of the countries attempt to achieve this by formulating and implementing development plans without any serious effort to integrate environmental considerations into the process. The increasing degradation of natural environment and mounting public concern about environmental problems and issues, organisations now have to account of environmental aspects in their corporate decision making and strategic planning.

Pipelines (due to the efficiencies they bring to the business model) have rapidly replaced other conventional modes of transporting crude and petroleum products such as rail, road and ship. Pipelines currently transport about 30% of India's fuel consumption. The international pipeline market in the last 5 decades has witnessed significant technological advancement such as the use of 'intelligent pigs' to clean the interior of pipelines, use of 'batching' to transport different petroleum products through the same pipeline, use of cathodic protection to reduce corrosion of

pipelines, and use of computers and communication technologies to monitor and control pipeline operations, to emerge as the preferred mode of transport.

Importance of pipelines - the Indian scenario

For decades, India has survived on a minimal oil and gas pipeline infrastructure. Given that transportation cost accounts for roughly 25% of the product cost, in the current Indian decontrolled scenario and the anticipated cut-throat competition, companies transporting their products through pipelines will be able to cut product costs, charge lower prices and thereby, increase market share. Pipelines are the most cost-effective way of transporting crude, petroleum products and gas. Industry reports indicate that it costs barely Rs 1.30 per km to move every ton of oil products by pipelines while railways cost Rs 2.20 per ton and road, Rs 3.02 per ton. The growth in pipelines has stagnated to accommodate the demand from railways to use oil tankers for transportation of oil. Going forward, the growth of pipelines is likely to increase rapidly for several reasons such as increasing urbanization and greater concern for environment and safety; dismantling of controls in the oil sector, leading to greater flexibility for development and utilization of pipelines.

Advantages of pipeline transportation

Lower losses in transit over other transportation option, Large-scale economies in transportation Cost of usage of pipelines is expected to decrease further over time (owing to decreasing depreciation and interest costs) Environmental impact during construction, operation and maintenance is negligible and reversible, making pipelines, an environment friendly option Other transportation options may require specific containers for specific products, pipeline transportation can handle multiple products. India has less than 15,000 km of oil and gas pipelines; in comparison to France (which is roughly the size of the Indian states of Rajasthan and Punjab combined) has 170,000 km of pipelines. The US, on the other hand, has 329,600 km of pipelines. Pipelines are the most cost-effective way of transporting crude, petroleum products and gas. Industry reports indicate that it costs barely Rs 1.30 per km to move every ton of oil products by pipelines while railways cost Rs 2.20 per ton and road, Rs 3.02 per ton. The growth in pipelines has stagnated to accommodate the demand from railways to use oil tankers for transportation of oil. Going forward, the growth of pipelines is likely to increase rapidly for several reasons such as increasing urbanization and greater concern for environment and safety; dismantling of controls in the oil sector, leading to greater flexibility for development and utilization of pipelines. Our country needs huge pipelines infrastructure to connect future sources of gas supply with potential consumers. Gas sector and gas transport in particular developing rapidly in India. The increases in demand are driven by several forces, but perhaps most importantly, are the powerful

Regulatory trends toward cleaner air and reduced greenhouse gas emissions that are forcing companies to accelerate efforts to reduce emissions of sulfur, nitrogen, carbon, mercury, and other pollutants. This is forcing many firms to increase use of natural gas and to gradually decrease the use of other fuel sources. In fact, natural gas has increasingly become the "fuel of choice" by both the environmental community and industry as an acceptable alternative in the transition away from coal, nuclear power, and hydroelectric power.

Need for pipelines

- Hydrocarbon Vision 2025 suggested 45 % share of pipelines
- Required Pipeline capacity estimated at 105 MMTPA in 2024-25

Year	Product Demand (MMTPA)	Industry pipeline Capacity (MMTPA)	% Share of Pipeline
2001-02	100.00	38.00	38.00
2002-03	107.00	46.00	42.99
2006-07	124.00	51.00	41.13
2011-12	148.00	65.00	43.92

Pipelines Economics - Indian scenario

India seems poised to increase the existing pipeline network (product and gas) in the near future. It is, thus, essential, to understand the dynamics of the business and regulatory factors and their impact on the economics of laying pipelines and/or expanding existing pipeline networks. Like other infrastructure projects, pipeline projects have significant associated risks -

Requirement for large investments in the establishment of operations

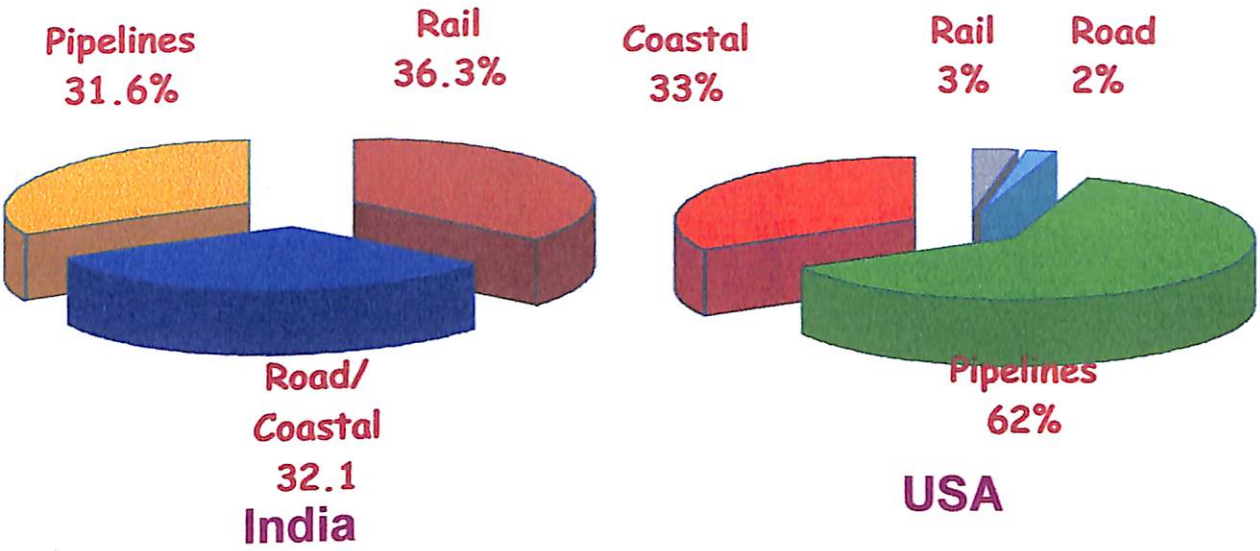
Long gestation periods prior to which returns on investment are negligible

Potential time and cost overruns

High uncertainty in demand cycles over the long operating life of projects

Limited alternative uses for assets created Uncertainty about the regulatory regime in which the projects would have to operate

Mode-wise Transportation of Petroleum Products

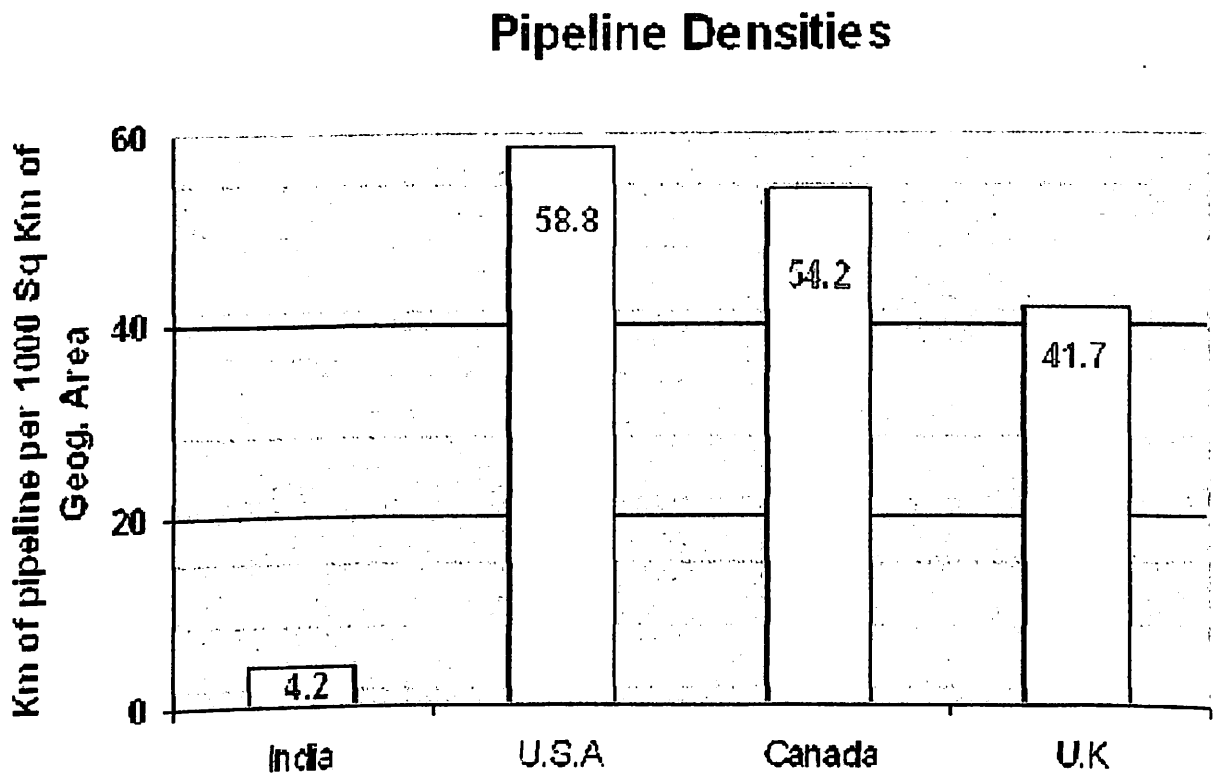


Source PPAC Data book

Indian scenario is bound to follow US mode as all the factors are favourable

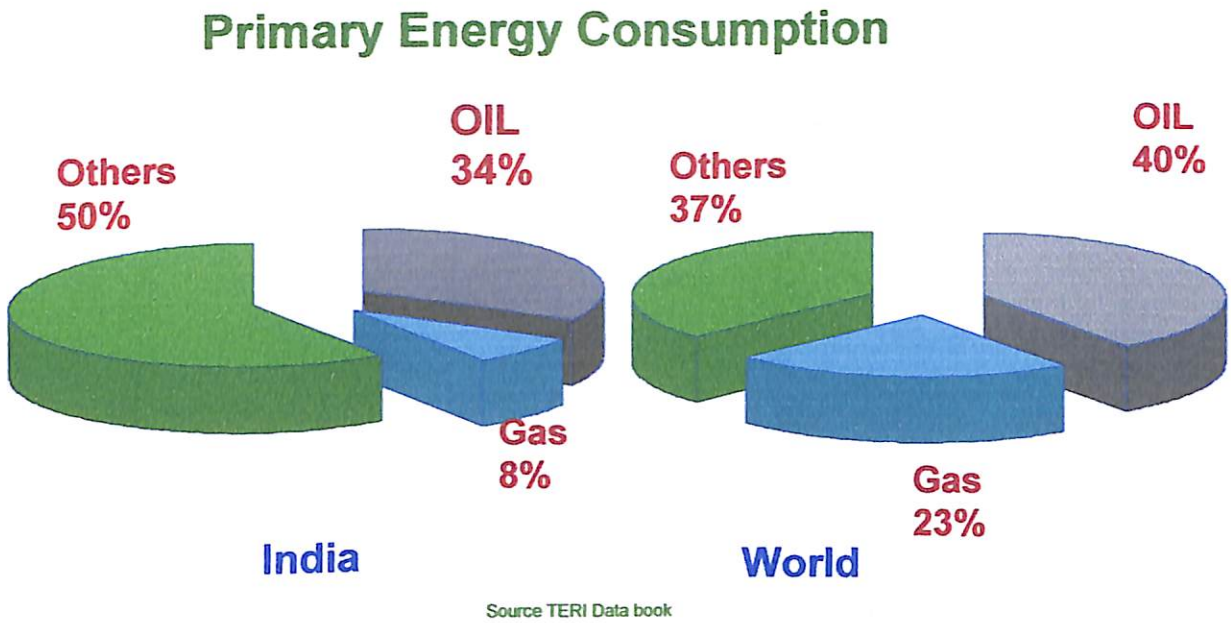
The pipeline infrastructure in US is as much as more than double, while in our country rail and road mode of transportation is dominant, which clearly shows the ground which we have to cover.

Infrastructure comparison: Overall



Tremendous scope of pipelines development need a conducive environment for speedy development

India is one of the fastest growing economy in the world while infrastructural development is catching pace, in such times investments in capital intensive projects like pipelines which have long term benefits and longer payback period are ventured into. Such developments have already taken in the Developed countries like US and for the economic benefits India will have to follow them.

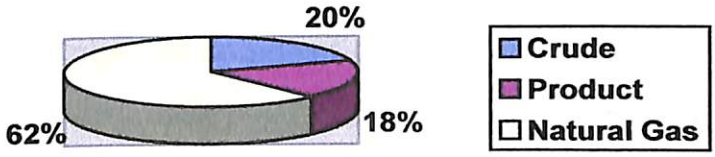


With big Gas find in K-G Basin (By Relinace), which is estimated between 10-14 tcf and in Cambay Basin keeping in view the demand supply gap, environmental regulations, eagerness of the Government and Industry to go for use of Natural Gas, expedience on the laying of gas pipelines is inevitable in our country.

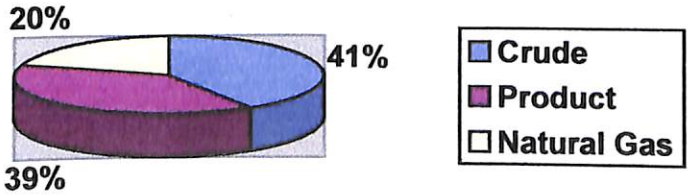
A comparative study of pipeline composition between India and US clearly shows that we are more dependent on crude pipelines till now but this scenario is very likely to change in the favour of Gas pipelines and look more like that of US where Gas pipelines are as much as three times the crude pipelines.

Pipeline Composition : Comparison

Composition- US



Composition- India



With new finds, Gas pipeline would dominate Indian scenario

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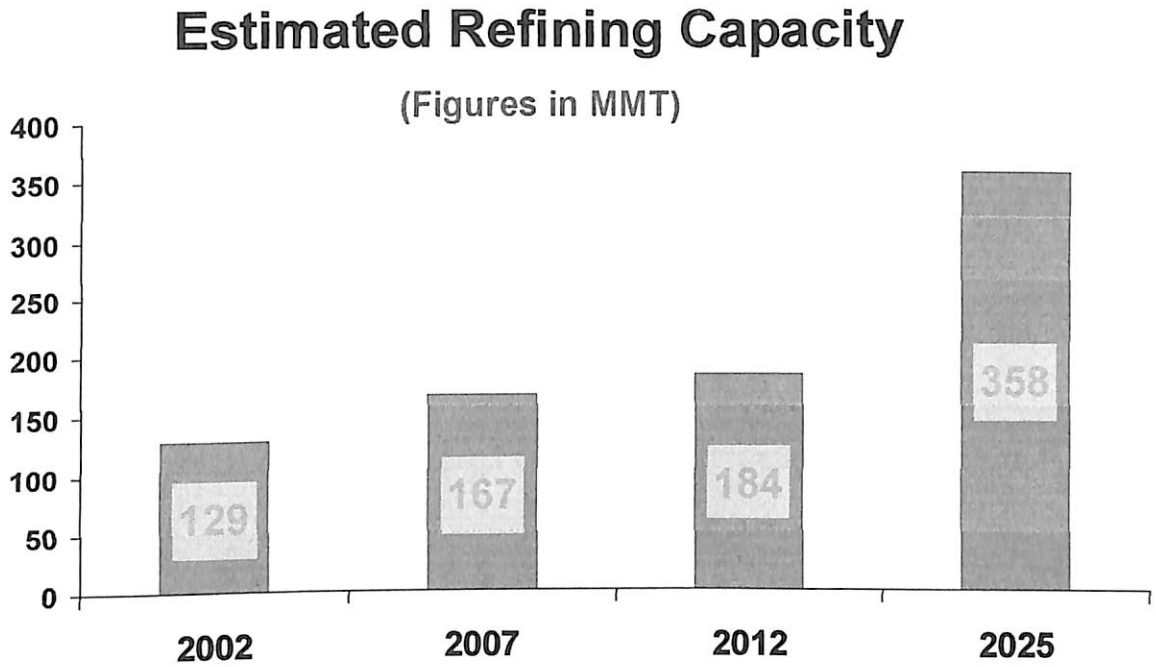
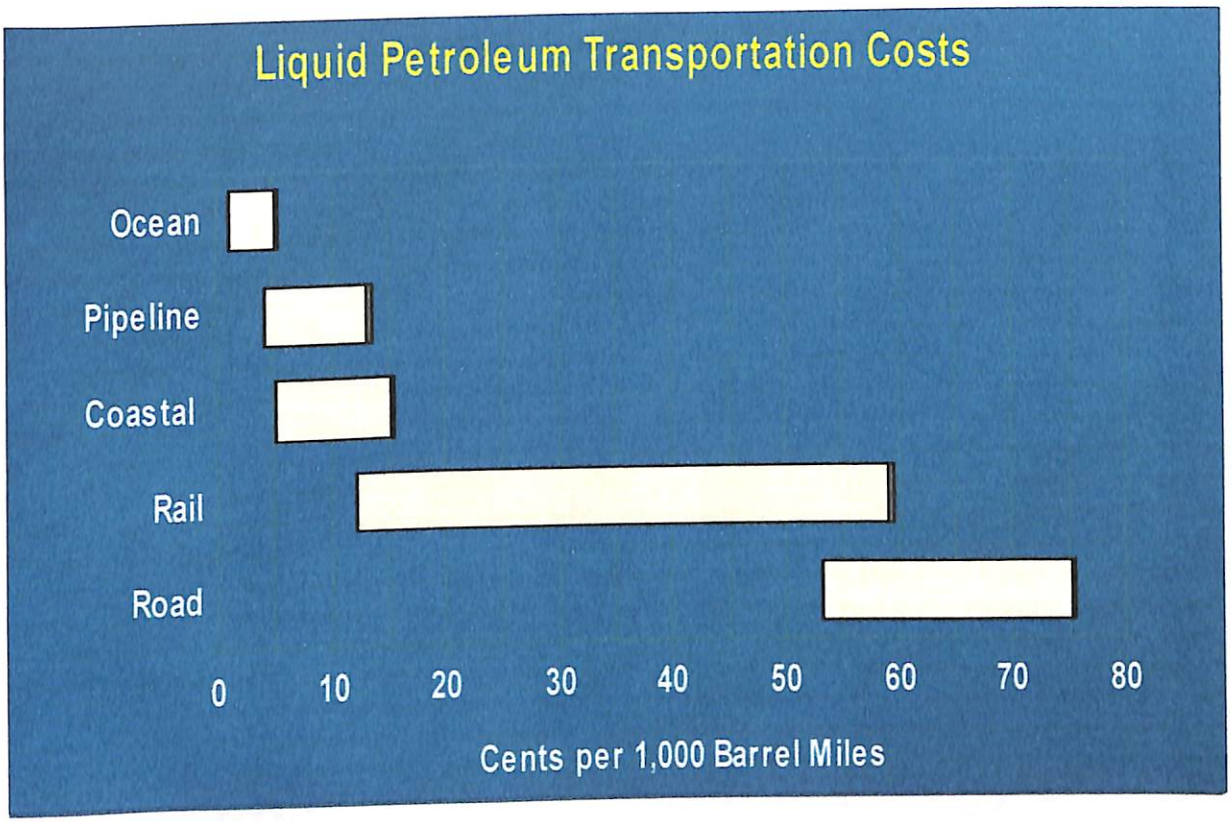


Source : Hydrocarbon Vision 2025

It is evident that with increasing demand of petroleum products transportation infrastructure (pipeline) development plan has to be put into place.

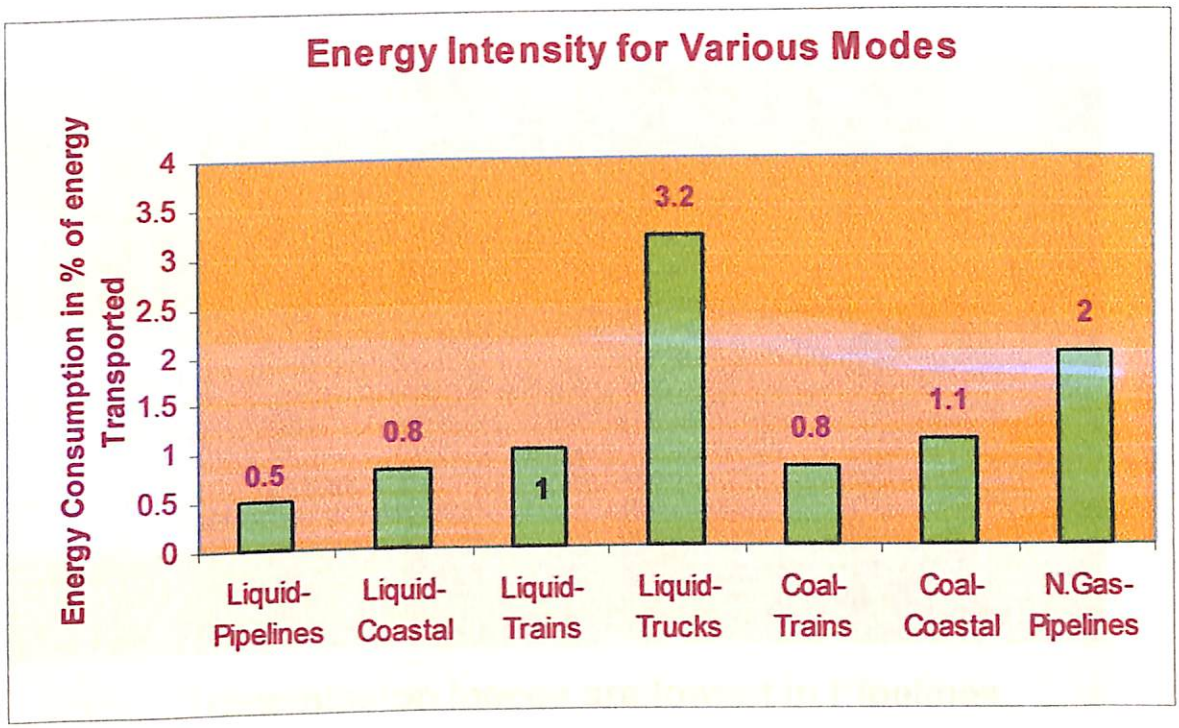
Cost Advantage



Pipelines are the most economical mode of inland transportation of liquid hydrocarbon

A comparative study of Pipeline mode of transportation of liquid petroleum through Tankers (in ocean), Barges (coastal), rail and road mode of transportation clearly indicates that pipelines are the most economical mode of inland transportation of liquid transportation.

Energy Savings

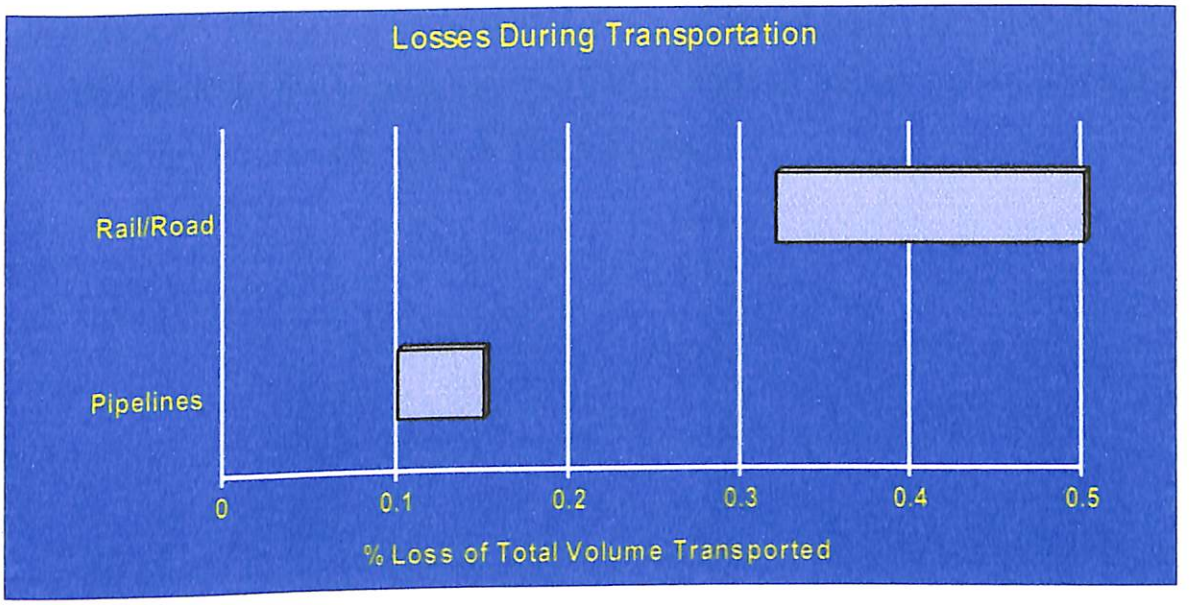


Pipelines are the most energy efficient modes of transportation

Hydrocarbons are nothing but resources of Energy, when hydrocarbons are transported it is evident that energy would be consumed in the process, a comparative study of liquid pipelines mode of transportation clearly indicate the edge it has over other mode of transportation when energy consumption during the process is taken into account . This is so because once pipelines are being laid energy is consumed in pressure maintenance while the product moves through it to the customer.

Energy consumed in Natural gas pipelines is however relatively high yet the other benefits of natural gas pipeline (gas being more available, economical and environment friendly) puts Natural gas pipelines in good stead.

Transmission losses



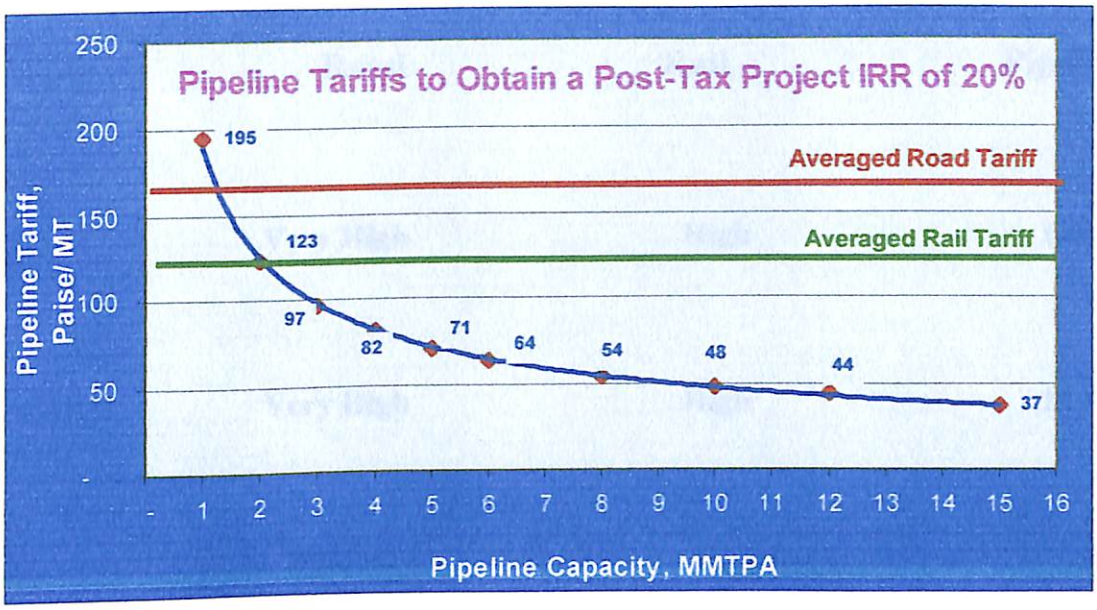
Transmission losses are lowest in Pipelines

Relative Efficiencies

Mode	Energy Consumption	Handling Losses
Road	1700	0.5-1%
Rail	320	0.3-0.5%
Pipelines	50-135	0.02- 0.05%

Hydrocarbons loss primarily due to spillage, vaporization and negligence in handling are evident, a comparative study of liquid pipelines mode of transportation clearly indicate the edge it has over other mode of transportation when transmission loss during the process is taken into account.

Tarrif advantage



Finally, profitability is highest compared to other modes

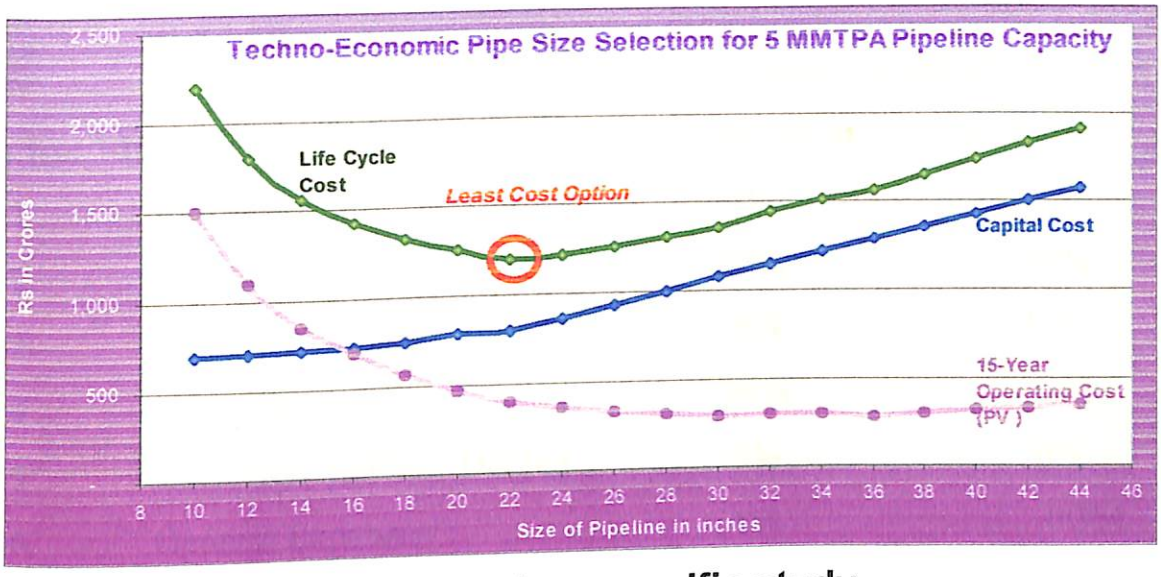
To obtain about 20% rate of return studies have confirmed that if the capacity of pipeline is more than 2MMTPA, pipeline tariff paid per Million Ton of product transported would be much lower than Road as well as Rail tariff. So pipelines should be planned when demand is high and higher the demand, more profitable they proves out to be.

Comparison with Alternate Modes

Head	Road	Rail	Pipeline
Energy Cost	Very High	High	Low
] Operating Cost	Very High	High	Low
Storage Cost	Very High	High	Low
Pollution	High	Low	Nil
Movement Congestion	High	Low	Nil
Handling Losses	High	Low	Negligible
Safety Hazards	High	Low	Negligible
Reliability	Low	Low	100%

Idealised parametric study:

Liquid Pipelines



Realistic case requires specific study

Capital cost: Typical breakup

Sr.No.	Items Description	Percentage of Capital cost	
		Liquid Lines	Gas Lines
1	Survey, ROW & Compensation	2%	1%
2	Line Pipe Steel cost	33%	45%
3	Main Line Materials	2%	3%
4	Costing of Pipes	11%	6%
5	Main Line Construction	33%	25%
6	Cathodic Protection	1%	1%
7	Telecommunication, SCADA& RCPs	5%	2%
8	Pump / Compressors Stations	5%	12%
9	Delivery Terminal Facilities	2%	1%
10	Project Management	5%	4%
11	SubTotal	100%	100%

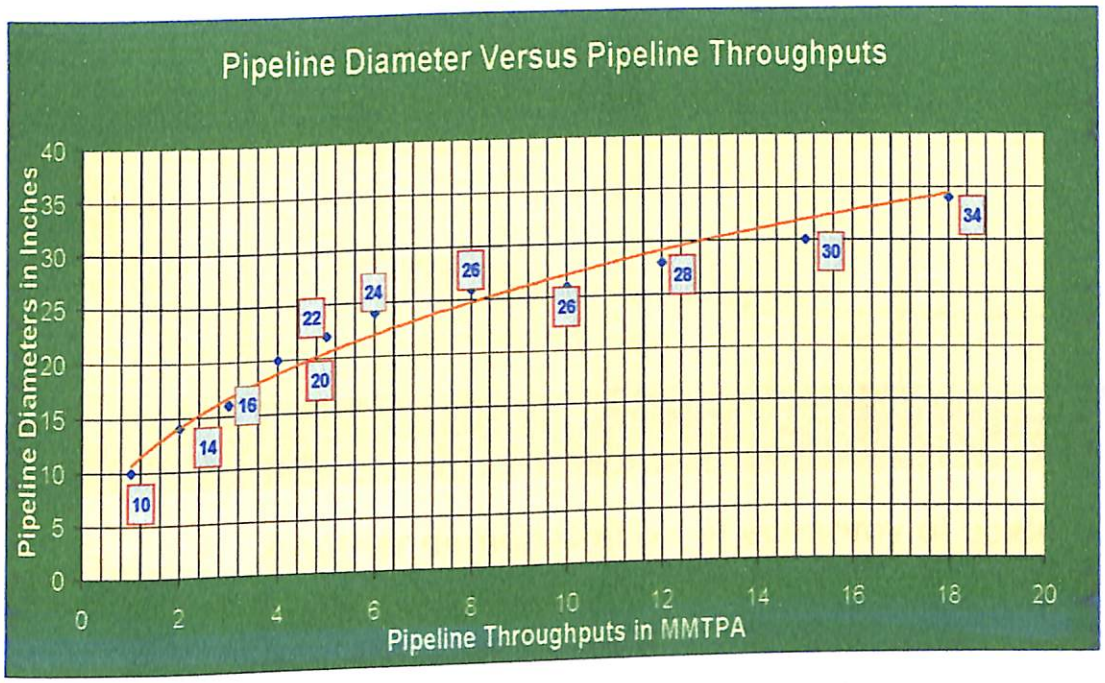
Pipes, prime-overs and construction constitute big ticket items

Annual O&M cost: Typical breakup

Sr.No.	Item Description	Percentage of O&M Cost. Liquid Lines	Gas Lines
1	Personnel	4%	0.3%
2	Station Maintenance	12%	16%
3	Maintain Maintenance	30%	15%
4	Energy Costs	24%	58%
5	Corrosion inhibitor Dozing	5%	0%
6	General Expanses	4%	0.3%
7	Insurance Charges	21%	11%
8	Sub Total	100%	100%

Energy is the dominant among O&M costs

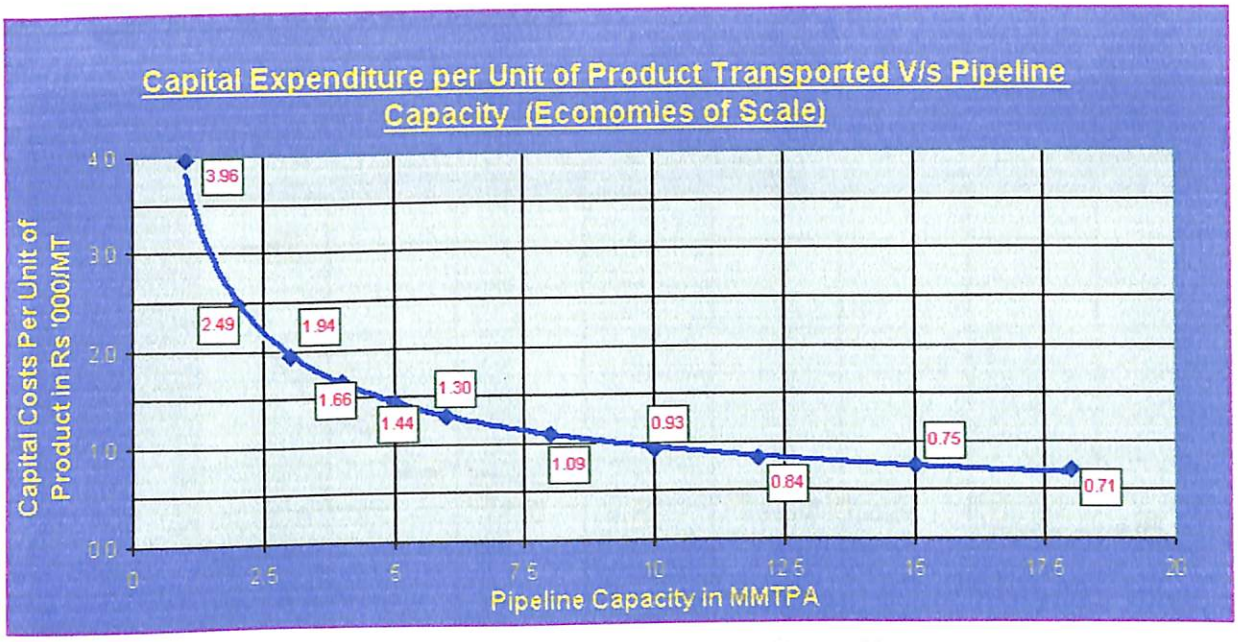
Optimal sizes of various capacities



Economy of scale

According to the future demand scenario of oil in a particular region, pipeline throughputs are established and corresponding diameter of the pipeline is selected so that economy of scale is achieved when pipeline become operational.

Capex per unit capacity



Another demonstration of economy of scale

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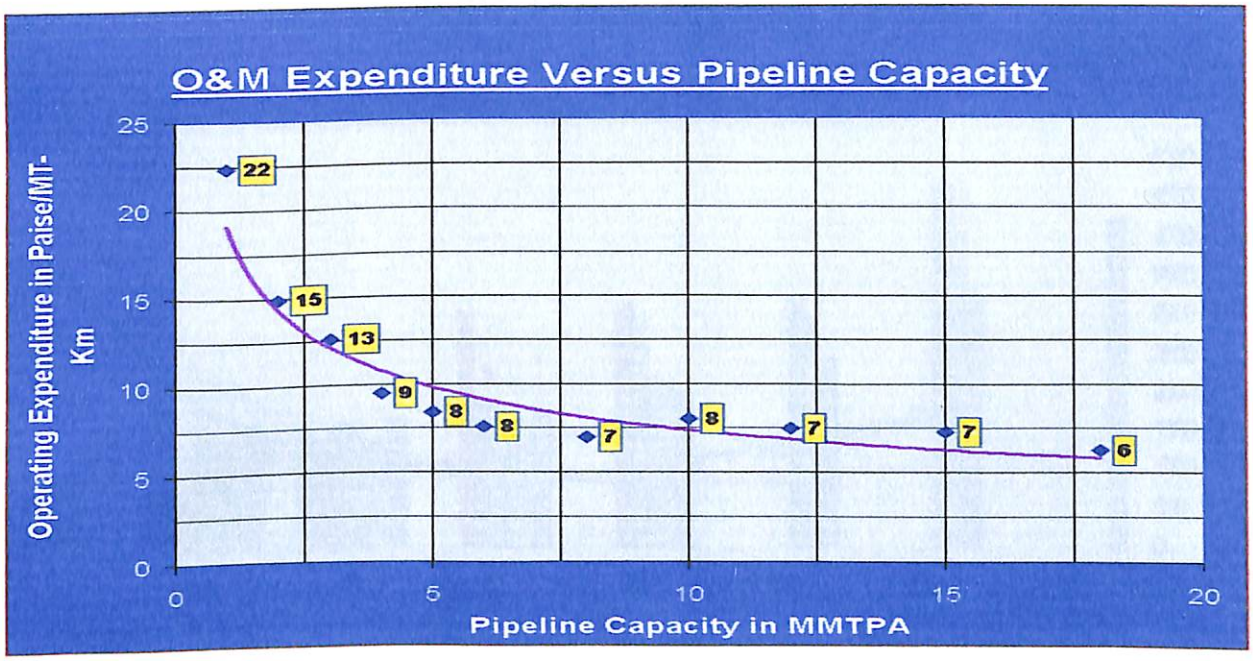
11	SubTotal	100%	100%

Pipes, prime-overs and construction constitute big ticket items

The capital costs per unit of product transported keeps on decreasing by a certain proportion when the pipeline capacity is increased, to establish economies of scale the above graph could be very helpful.

Opex per unit capacity



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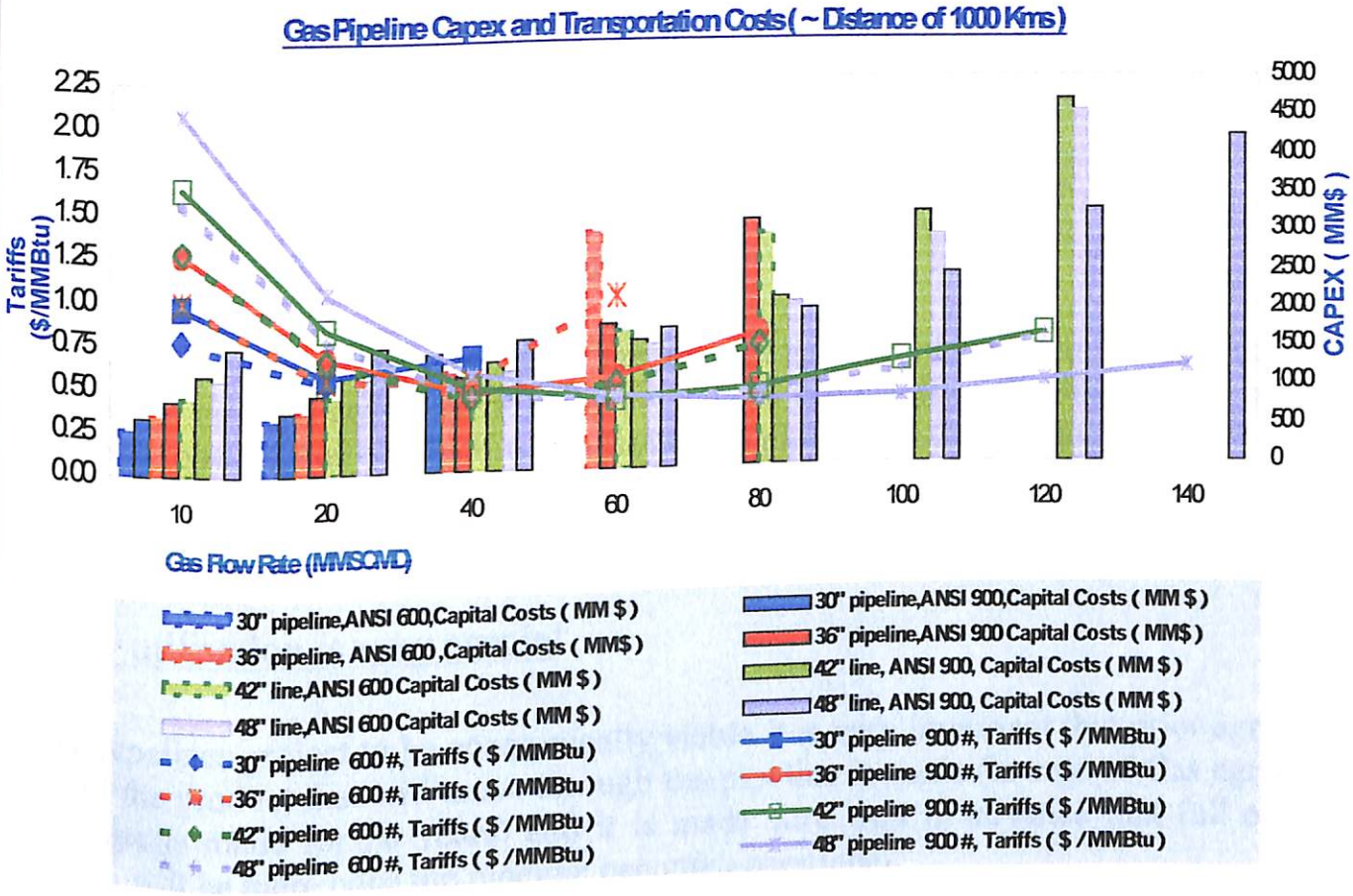
	Sub Total	**100%**	**100%**

Energy is the dominant among O&M costs

Gas pipeline: Idealised parametric study



New gas finds, supply – demand gap: India should prepare for big-inch high pressure pipelines

Weakness of Pipelines

Capital intensive:

Pipelines whether liquid or gas needs high investment (in Rs1000 crores) so before laying of the pipelines the techno economic feasibility needed to be established thoroughly.

Once laid, it is sunk cost/No alternate use:

Once the pipeline is laid and if in the near future due to certain reasons (political disharmony, terrorist activities etc) it is not safe to use pipeline, then there is no mode to recover the cost/part of cost incurred in laying the pipeline as there is no alternative use.

Capacity utilisation is very crucial

For the pipelines project to be economically viable it is very important that prior agreement of sale of the product that will move through the pipeline is made (in case of Gas agreement of purchase is made for 20 years) and it is made sure well in advance that full capacity utilization will be there once the pipeline become operational.

Change in supply logistics can make the project unviable

New discoveries of oil and gas fields as well as locations of refineries can bring all together new dimension to supply logistics of oil/gas which can make existing pipeline unviable

solume comfort is a pre-requisite:

The range of Volume of the products that will flow through the Pipelines is pre determined and for that volume, pipes and other equipments are designed any change in beyond the range will not be feasible thereafter.

Market Driven tariff:

In the free market scenario if the tariffs keep on changing it will create a kind of uncertainity of return to the investors.

Interface and contamination of product:

In pipeline different products are transported like motor spirit, Diesel and kerosene at different intervals so purity of the product is affected due to mixing of small proportion of one product into another.

Door to Door delivery not possible:

In Indian context, cities are not well planned and to lay pipeline upto the door of the customer can not be economically viable.

Conclusions:

- Pipelines are the most efficient, economical, environmental friendly , safe and reliable(Disturbances above ground don't affect) mode of liquid/gas transmission

- Cost effective- depending upon capacity utilization

- For Gas, there is no other option than pipeline mode of transportation

- Pipeline density is negligible in comparison with developed countries the scenario will have to change

- Recent Gas finds and surplus refining capacity can only spur growth of pipeline infrastructure

- Regulatory support is necessary, to enable speedy development of pipeline infrastructure in our country

- Utilization of energy considering benefits of pipeline infrastructure (specially for gas) can stimulate national economical growth and improve quality of life

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