Sub-Saharan Petroleum Products Transportation Corridor

Analysis and Case Studies

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Joint UNDP/World Bank Energy Sector Management Assistance Programme

(ESMAP)

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Preface

Within the framework of the Energy Sector Management Assistance Program, the World Bank undertook a study to review the transportation of petroleum and petroleum products in sub-Saharan African (SSA) countries. The study has focused on landlocked countries where the transportation costs are disproportionately high; its main objective is to identify areas for rationalization.

Previous studies that reviewed the hydrocarbon sector and, in particular, the fuel trade in SSA, have confirmed that the transport component of the consumer price for petroleum products in this region is: (i) disproportionately high and (ii) exposed to far more risks, as compared to developed countries. The landlocked SSA countries, especially, depend on their neighbors for the transit of hydrocarbon products.

Economic growth in developing countries is strongly linked to a proportional growth in energy consumption. All projections of energy consumption for SSA agree that petroleum products will continue to play a key role in transport, commercial, and residential sectors. Thus, secure and efficient means of hydrocarbon transport are critical for the development of these countries.

However, for landlocked countries, geography dictates a high degree of dependence on transit countries for the import of hydrocarbons. This dependence is intensified by geopolitical forces and environmental concerns about petroleum shipping routes, which are not always by the shortest, that is, most efficient route to market. A main obstacle to enhanced trading of petroleum products across borders is that bilateral or multilateral agreements among the SSA countries are either not in place or are poorly implemented. The lack of stable bilateral or multilateral trade agreements and of environments friendly to business investors, weaken cross-border trade and attractiveness for private sector investment in the petroleum transport sector.

This study examines whether regional transport of petroleum products by pipelines and improved trade behavior would have a high potential to rationalize hydrocarbon transport to landlocked SSA countries. The paper is structured in four main sections: (i) a brief description of the sector settings, describing the status quo of petroleum transport facilities in SSA and, in particular, in landlocked counties; (ii) a general description of the economic principles that govern the transport of petroleum products; (iii) an insight into regulatory frameworks that enhance private sector investment by reducing the investor's risk in transport-related projects, including the role that bilateral and multilateral agencies can play to promote private sector deals; and (iv) case studies that have been carried out to consider a number of proposed regional pipeline infrastructure projects and their potential benefit in terms of transport cost and security of supply. In the end, the paper recommends additional work in this sector.

Abbreviations and Acronyms

ADAC	Allgemeiner Deutscher Automobil Club
ADB	African Development Bank
AGO	Automotive Gas Oil
Bbl	Barrel
Bn	Billion (US equivalent - one thousand millions**)**
CAPEX	Capital Expenditures
CIF	Cost, Insurance, and Freight
CPV	Cumulative Present Value
CPVk	Cumulative Present Value of the Sum of Investments and Operating Costs
DPK	Dual-Purpose Kerosene
DWT	Dead Weight
ECGD	Expert Credits Guarantee Department
ECT	Energy Charter Treaty
EDC	Engine Distribution Center, Inc.
ESMAP	Energy Sector Management Assistance Program
FOB	Free on Board
FOC	Foreign Oil Company
GDP	Gross Domestic Product
GoN	Government of Nigeria
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit GmbH
HSE	Health Safety and Environment
I	Investment
IDA	International Development Association
JBIC	Japan Bank for International Cooperation
k	Annual operating expenses
km	Kilometer
L	Transportation Length
MBtu	Million British thermal units
MTA or Mt/a	Million tons per annum
MWh	Megawatt Hour
NNPC	Nigerian National Petroleum Corporation
OPEX	Operational Expenditures

OPIC	Overseas Private Investment Corporation
PMS	Premium Motor Spirit
PPMC	Products & Pipeline Marketing Company
PSA	Production Sharing Agreements
Q	CPV of the throughput both for a certain period of time and for a certain discount factor
SA	Southern Africa
SACE	Italian Export Credit Agency
SADC	Southern African Development Community
SCADA	Supervisory Control and Data Acquisition
sk	Specific Transportation Costs
SOE	State-Owned Enterprise
SSA	Sub-Saharan Africa
UNDP	United Nations Development Program
US	United States
US$	US Dollars

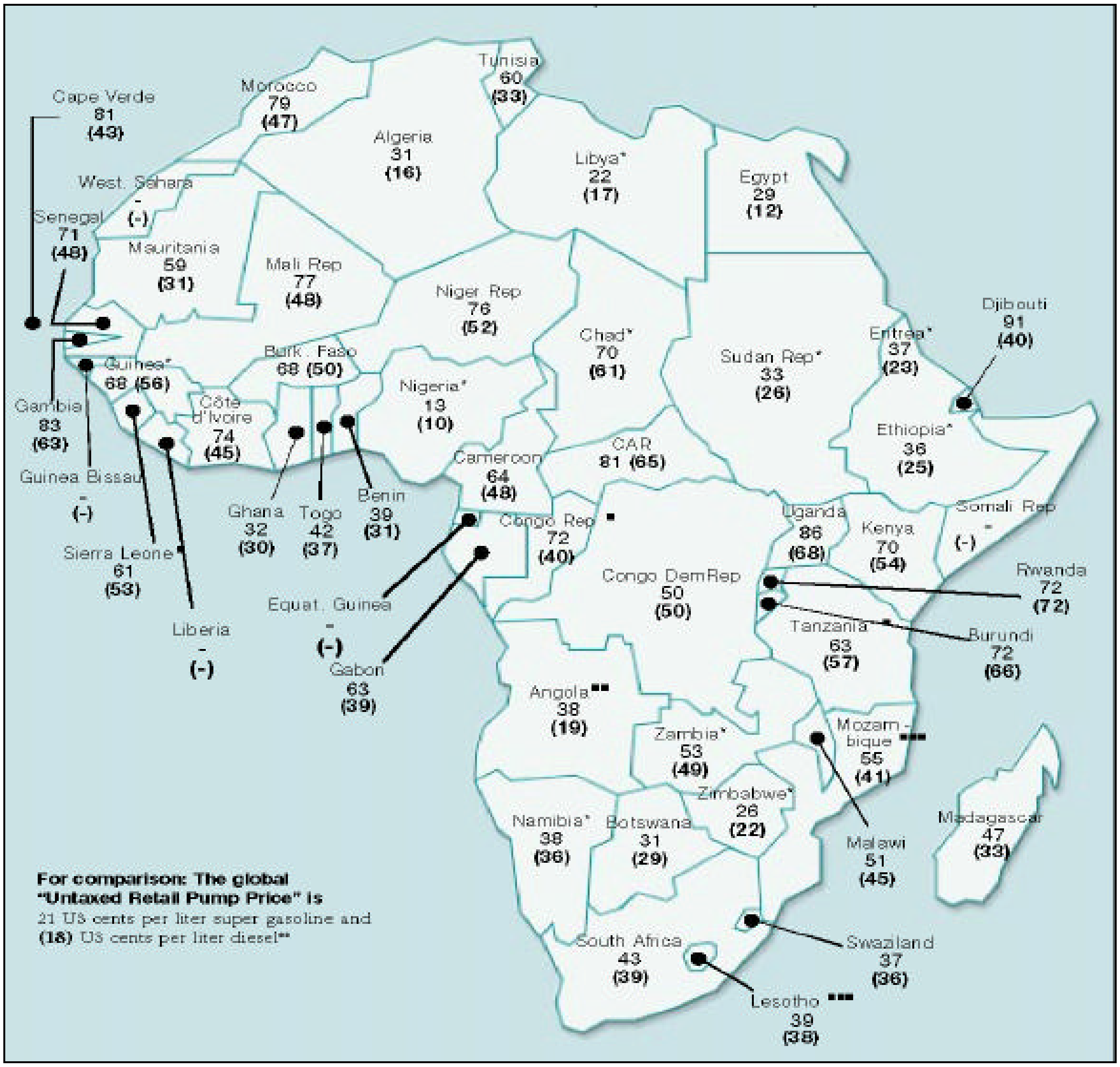
1

Sector Setting

Comparison of Untaxed Fuel Prices of Petroleum Products

1.1 The transport of petroleum products from seaports to the sub-Saharan (SSA) landlocked countries of Africa is invariably expensive. Figure 1.1 and Table 1.1 give an overview of untaxed retail prices paid by African consumers, compared to average global prices. It is assumed that, since November 1998, petroleum product prices have not changed significantly in the majority of these countries. The table points out, however, the relatively high cost of fuel in SSA as compared to the rest of the world; the average untaxed US fuel price is considered a good global reference.

Figure 1.1: Fuel Prices in Africa in US cents per liter of Gasoline (Diesel in Parentheses), November 1998



*Price for regular Gasoline;

¦ Prices as of Feb. 1997; ¦ ¦ Prices as of Feb. 1998; ¦ ¦ ¦ P r ices as of June 1998

Source: *Fuel Prices and Taxation* by GTZ, May 1999.

Table 1.1: Pump Prices for Super Gasoline and Diesel (in US cents per liter), 1991–1998

Fuel Prices in US cents per liter										
	Super gasoline				*Diesel*				*Source & date of 1998 data*	
Country	*1991*	*1993*	*1995*	*1998*	*1991*	*1993*	*1995*	*1998*	*Source*	*Date*
US "untaxed pump price"				23				18		
Algeria	15	20	40	31	4	9	23	16	ADAC	Dec 98
Angola				38				19	World Bank	Feb 98
Benin	63	62	36	39	48	47	28	31	GTZ	Nov 98
Botswana	68	41	38	31	61	37	35	29	GTZ	Nov 98

Oil Market in SSA: Low Consumption and High Distribution Costs

1.2 In general, energy consumption in SSA is very low; in fact, the SSA region has, on average, the lowest energy consumption per capita in the world—15 MBtu per person per year. The markets for petroleum products, therefore, are very small, and consumer density is extremely low. For that reason, economies of scale for the procurement of products and for distribution and marketing operations are not available, resulting in a much higher product distribution cost as compared to industrialized countries. In real monetary terms, the cost component for petroleum product distribution in the SSA region, particularly in the landlocked countries, is as high as US$0.5 per liter. In comparison, the average cost component for petroleum product distribution in Europe or the United States is as low as US$0.012 per liter.

Existing Infrastructure for Petroleum Transport in SSA

1.3 With the exception of Nigeria, sub-Saharan Africa is the region with the lowest density of pipelines in the world. This is mainly because of the low density of petroleum markets in sub-Saharan Africa. Transport of products by pipelines is limited to only a few product pipelines.

1.4 There are very few regional transport infrastructures in place, either by pipeline, road, or rail; the sector is characterized only by national or local transport and distribution infrastructure. In general, petroleum transport operations in SSA are not very well organized and not necessarily driven by macroeconomic considerations. Some of the existing product pipelines are run as profit centers by the operators, who abuse their monopoly and drive product distribution costs unnecessarily high.

1.5 The existing petroleum transport infrastructure is mostly in the hands of state oil enterprises and has often been misused to promote a geopolitical agenda, rather than to enhance industry operations that follow market forces.

1.6 The generally poor condition of the infrastructure affects the landed cost of petroleum products. Moreover, the frequently changing supply patterns and growing insecurity of the supply of petroleum products adds greatly to the generally poor investment climate which exists in most economic sectors in the SSA region.

1.7 South Africa has a fairly well-run railway network, which extends into Botswana and Zimbabwe. However, some of the rail tracks, particularly the ones in Botswana and Zimbabwe, frequently become unusable from poor maintenance or damage by natural disasters.

1.8 In cases of the absence of pipelines or failures in the rail system, petroleum transport reverts back to road tankers, a situation which leads to an overall reduction in supply security. Road transportation of petroleum products involves (i) a significant increase in transportation costs; (ii) continuous disruptions in supply patterns, (iii) extensive damage to the existing road infrastructure from heavy trucks; and (iv) a significant increase in road accidents.

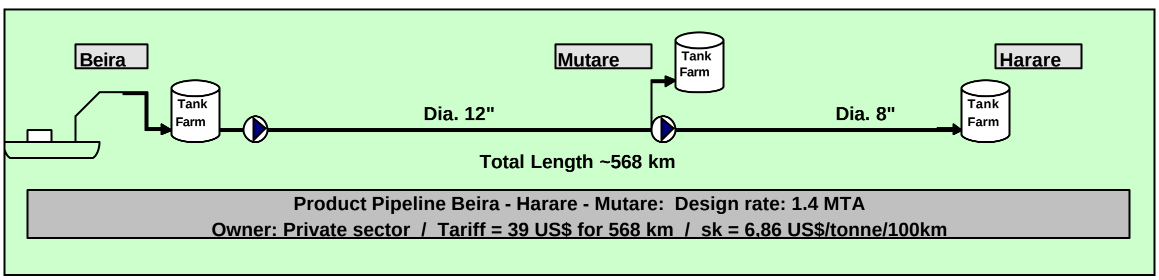
Existing Pipeline Infrastructure

1.9 Outside of Nigeria and the Union of South Africa, the existing pipeline infrastructure in SSA is limited to a handful of pipeline systems existing mainly in East Africa. Most of the pipeline systems could include profitable extensions. The section below provides a schematic overview of the existing pipelines and their financial tariffs, with the corresponding "sk" (specific cost in US$/100km) figure for comparison to other systems.

Beira (Mozambique)-Harare Product Pipeline

1.10 This is a 12-inch diameter pipeline, currently transporting only about 700,000 tons per year of products for Zimbabwe alone. Up to its first stop of Mutare, Zimbabwe, it can transport about 2.0 million tons per year of products. If this line is extended to Lusaka, Zambia from Harare by a 6-inch diameter pipeline, nearly all of Zambia's present consumption of about 0.5 million tons per year can be delivered at the least cost.

Figure 1.2: Schematic Overview of the Product Pipeline from Beira via Mutare to Harare

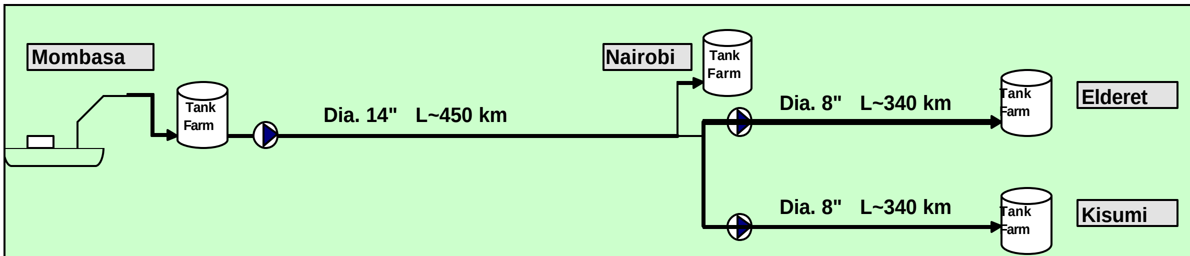


Mombassa-Nairobi-Kisumi Product Pipeline

1.11 Up to Nairobi, this pipeline is 14 inches in diameter; from there on, it is 8 inches in diameter. The 14-inch section can transport about 4.0 million tons per year, and the 8-inch section about 1.0 million tons per year. At the moment, transportation to Nairobi is limited to about 2.4 million tons per year. Consumption in the Kisumi area in Kenya is only about 300,000 tons per year. To increase the cost effectiveness of the pipeline, another project should be developed to provide petroleum barge loading facilities in Kisumi and a few petroleum barges to transport the products over Lake Victoria to Uganda and to northwest Tanzania. With this additional transportation, about 350,000 tons per year could be delivered to Uganda and 150,000 tons per year could be delivered to Northwest Tanzania at the least cost [1].

[1] This project was included in the Kenya Energy Project, but was deleted for speedy Board Presentation of the power project, after appraisal. It can be easily revived as part of the next energy sector project, which was the original intention.

Figure 1.3: Schematic Overview of the Product Pipeline from Mombasa to Nairobi and to Elderet and Kisumi



Product Pipeline Mombasa - Nairobi - Kisumi / Nairobi - Elderet:
Owner: Kenya / Tariff = 31 US$ for Mombasa - Nairobi / sk = 6,74 US$/tonne/100km
Tariff = 56 US$ for Nairobi - Elderet/Kisumi / sk = 4.58 US$/tonne/100km for Export only
Tariff = 51 US$ for Nairobi - Elderet/Kisumi / sk = 4.58 US$/tonne/100km for Domestic use only

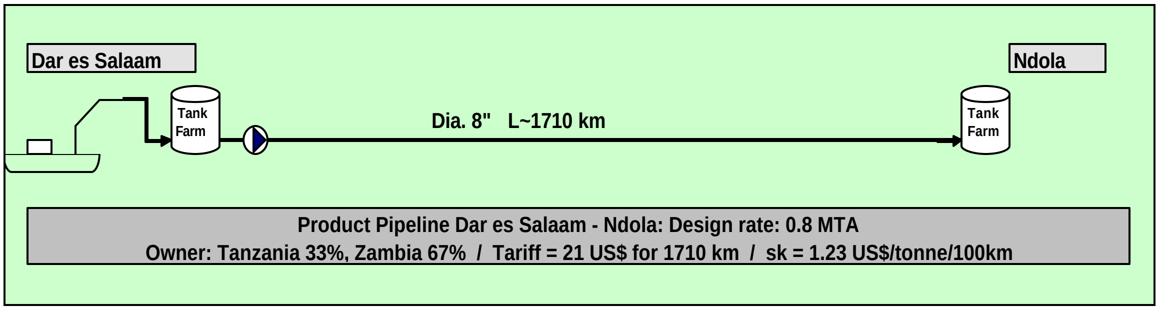
1.12 By building a 6-inch diameter branch line from the pump station before Nairobi to Moshi/Arusha in Tanzania, about 150,000 tons per year of products could be supplied at the least cost, reducing a considerable amount of the present environmental and road safety problems in transporting products from Dar es Salaam.

Dar es Salaam–Ndola (Zambia) Crude Oil Pipeline

1.13 This was originally an 8-inch diameter product pipeline. It was converted to crude oil service when the INDENI refinery was built in Ndola. Its rated pumping capacity is about 1.0 million tons per year. Currently, the pipeline pumps about 500,000 tons of crude oil per year to keep the refinery running. The estimated loss of keeping this refinery running is about US$16 million per year.

1.14 It was suggested to the Government of Zambia to conduct a comprehensive petroleum supply option study, including the relative economics of keeping the refinery in operation. If this line is converted to product service, by providing tap-off connections along its 1760 kilometer route, products can be supplied to Tanzania (150,000 tons per year), Malawi (300,000 tons per year), Burundi (50,000 tons per year), and Eastern Congo (50,000 tons per year), extending to Lubumbashi, the Copper Belt center of the Democratic Republic of the Congo (100,000 tons per year), which is over and above Zambia's own requirement. The savings to the country, without any competition from other transport sources, will be in foreign exchange. Such savings would have to be compared to the benefits of keeping the refinery operating.

Figure 1.4: Schematic Overview of the Product Pipeline from Dar es Salaam to Ndola



Comparison of Transport Tariffs for the Existing Pipelines in SSA

1.15 This comparison illustrates that, although the economic environments (that is, size, throughput, and utilization) for all three pipeline systems are comparable, there are significant differences in the tariffs that are charged to the shippers. The tariff charged for the Dar es Salaam to Ndola pipeline – 21 US$ per ton for the 1710 km of distance- is equivalent to a sk of 1.23 US$/100km and corresponds to tariffs charged on similar pipelines in Western Europe, which operate on a cost-plus basis. However, the operators of the other two pipelines appear to abuse their natural monopoly and overcharge for the transport of petroleum products.

?? In the case of the pipeline from Mombassa to Nairobi the tariff of 31US$ pet ton for the 450 kms indicates a sk 6.74 US$/ton/100km . For the following sections, in the case of exports, the tariff of 56 US$ per ton for the use of the pipeline between Nairobi – Elderet/Kizumi is equivalent to a sk of 4.58 US$/ton/100km. In the case of a domestic use, the tariff of 51 US$ per ton in this pipeline is equivalent to a sk of 4.17 US$/tonne/100km.

?? In the case of the pipeline from Beira to Harare – via Mutare the tariff of 39 US$ per ton is equivalent to a sk of 6.86 US$/ton/100km. This is a privately owned pipeline that appears to be unregulated.

Proposed Pipeline Infrastructure

1.16 Consumption of petroleum products in countries in sub-Saharan Africa, except South Africa and Nigeria, is so small that the economic viability of bulk transport systems such as pipelines could be enhanced by pooling together the requirements of a few countries and by developing a transport infrastructure on a regional basis. Such regional transport systems could reduce the delivered cost of petroleum products considerably, reduce fuel consumption, and losses in petroleum transport (thereby reducing environmental pollution) and improve safety on the major highways by reducing long-distance petroleum truck movements. The regional concept in petroleum transportation could be considered for the existing pipeline systems, as well as for new pipelines to feed areas consuming more than one million tons per year. In general, regionalization improves operational efficiency, reduces the delivered cost of petroleum products, and helps in improving human safety and reducing environmental pollution.

Extension of the Product Pipeline Network of Nigeria

1.17 Once the Nigerian downstream oil industry becomes commercially oriented and profit-oriented, the existing product pipeline network could be extended by three small (4- or 6-inch) pipelines to supply products to Niger in the north, Chad in the east, and Cameroon and the Central African Republic in the southeast. Currently, these landlocked areas get the products by road, paying as much as US$180 per ton and incurring heavy losses during transportation.

Durban-Johannesburg Product Pipeline

1.18 This is an 18-inch diameter pipeline, currently supplying products to Johannesburg and surrounding areas. By extending this line through two 6-inch-diameter branch lines to Gaborone and Bulawayo, the petroleum requirements of Botswana and western Zimbabwe could be met at the least cost. These locations are currently supplied by rail tank wagons from Durban.

New Regional Pipeline Possibilities

1.19 Once political stability is achieved and appropriate commercial arrangements can be established, there are a few new regional petroleum product pipelines that may be economically viable and beneficial to the countries in the region, particularly the landlocked countries. Two of the most important projects that could be considered in this context are the Djibouti-Addis Ababa Product Pipeline and the Lobito-Transvaal Product Pipeline.

Djibouti-Addis Ababa Product Pipeline

1.20 With the creation of an independent Eritrea, Ethiopia has become landlocked and depends on imports to meet its growing demand for petroleum products, which is currently about 800,000 tons per year. The most suitable deep water port facility for Ethiopia is Djibouti, and a pipeline to Addis Ababa would pass through most of the major consuming areas outside Addis Ababa, such as Dire Dawa, Harer, Awash, and Nazret.

1.21 The pipeline would run almost parallel to the existing rail and road lines from Djibouti, avoiding any major problems concerning right of way and environmental protection. With a capacity approaching 1.0 million tons per year, the economic viability of the pipeline vis-à-vis road or rail transport appears to be attractive. However, a pre-feasibility study, including a site survey, is suggested to verify the costs and to confirm the pipeline's economic viability. Cooperation between the Governments of Djibouti and Ethiopia is essential, and it does not seem to be a problem, since a considerable amount of goods is already moving into Ethiopia through Djibouti.

1.22 Djibouti has a deep water harbor to unload product tankers of an average 35,000 ton capacity. The pipeline project will include sufficient storage tanks and related facilities for an unloading terminal in Djibouti. At the receiving points in Addis Ababa and other tap-off points, oil marketing companies would enhance their existing storage and related facilities and build new facilities where they are not now available. The pipeline could be owned and operated by the private sector as a "common carrier" with equal access to all oil marketing companies.

Lobito-Transvaal Product Pipeline

1.23 This would be a major regional pipeline for petroleum products from an export-based refinery in Angola to send products to most of the member countries of Southern Africa Development and Economic Cooperation—SADEC: Angola, Namibia, Botswana, Zambia, Zimbabwe, the Transvaal region of South Africa, and the Democratic Republic of the Congo (Kinshasa). The specific areas that would benefit from this pipeline are receiving products currently through rail and road systems extending nearly one thousand kilometers, with a very high cost in expenditures and in physical loss of products.

1.24 The Government of Angola has started negotiations with international oil companies for private sector participation in the proposed export refinery, currently planned to be in Lobito. Sonangol, the Angolan Government-owned organization, is the main organizer for the export refinery project. For product transportation, Sonangol was considering rehabilitation of existing rail systems which exist, in many parts, only on maps.

1.25 Even in the best of times, a rail facility like the existing one, even with maximum modernization, cannot transport more than about 3.5 million tons per year of products. For such volumes, pipelines or ocean tankers are the most efficient and least-cost options.

1.26 In 1998, a Bank mission discussed this idea with the Minister of Energy, Sonangol, and SADEC representatives, on the basis that donor funds would be available for preparing feasibility studies. They all supported the idea in principle and asked for specific terms of reference for a pre-feasibility study. Meanwhile, the civil war erupted again in Angola, and attention on such economic development problems became secondary issues. Perhaps, one should wait for better times to develop the idea further in this region.

2

Economic Principles of Petroleum Transport

2.1 A great potential to decrease the price of petroleum products for end users, especially in landlocked counties, lies in the rationalization of product transportation.

2.2 The cost of the infrastructure is a critical component of the price of petroleum products; however, much of this investment is outside the control of the industry participants.

Pipeline Transport

2.3 In terms of distinctive features, pipelines are typified not only by heavy up-front investment, but also by the dedicated nature and sunk costs of this investment. That is, once a project invests in laying a pipeline down, no one is going to dig it up for use elsewhere, in the event that the market, in the end, does not develop as foreseen, or that the pipeline becomes obsolete because a small part of it is interrupted. Pipelines usually have an economic life of 20 years and more, so the up-front investments involved are necessarily substantial and can only be amortized over a long period.

2.4 The heavy up-front investments also mean that transportation costs can represent a significant share of the value of the product. Transport is also an area of acute vulnerability, in that a potential bottleneck can render activities in the downstream investments in infrastructure useless and ultimately obsolete. Civil conflicts, lack of maintenance or repair, or even paralyzing contractual or regulatory differences are only a few of the risks that can block pipeline transport for a substantial period.

2.5 Most of the costs of oil and gas pipelines stem from investment and the financing of construction. Pipeline projects also incur costs for maintenance and insurance (usually expressed as a percentage of the investment), but contrary to the investment-related costs, these cease when the pipeline ceases operation. All the costs discussed so far are independent of the transported volumes. It is mainly the costs for the energy to run the compressors or pumps that depend on the throughput. Thus, the total costs for pipeline transport are largely independent of the volumes actually put through.

2.6 The issues involved in constructing and operating oil and gas pipeline projects include substantial uncertainties about the future, as almost all decisions must be taken in the pre-investment phase, and project participants will have few chances of later adjusting to unforeseen developments. Conversely, reliability and predictability give access to better financing conditions regarding risk spread, maturity, and amortization time. To the extent that (i) the investment in oil and gas pipelines is specific to one project, and (ii) the partners involved are, thereby, not subject to the discipline of markets or competition, the risk of opportunistic behavior by the partners involved emerges.

2.7 In any project whose investment and infrastructure are largely up front and lack alternative uses, the balance of bargaining power among the parties will shift significantly as soon as the costs of the project become sunk. In this way, a situation that is balanced at the outset can become obsolete if a party does not feel bound by the balance originally reached, a phenomenon known as the risk of obsolescent bargaining. In oil and gas projects, this risk is tangible. Once the pipeline is in the ground, the investors become clearly vulnerable to the imposition of new, extra-contractual terms by other parties—in other words, blackmail. For example, customers may threaten to change suppliers, or other partners, such as governments, may threaten to interrupt pipeline operations.

Additional Risk Considerations for Landlocked SSA Countries

2.8 To a considerable extent, transit risk derives from the distinct characteristics of pipeline economics. Pipelines have (i) high fixed capital costs; (ii) low variable costs; and (iii) low salvage values. However, profit-maximizing behavior implies that operations will continue as long as variable costs are covered, and some contribution is being made to otherwise unrecoverable fixed costs. Once pipeline operations have commenced, large unilateral increases in transit fees can often be imposed by the host country without making continued operation uneconomical.

2.9 For many SSA countries, geography dictates a high degree of dependence on transit countries for the import of petroleum products. This dependence is intensified by geopolitical forces and environmental concerns about oil and gas shipping routes, which create pressures for pipelines that are not always the shortest route to market.

Determination of Transportation Cost for Petroleum Products in Pipelines

2.10 In order to make pipeline transportation costs comparable to other modes of transportation (that is, road tanker and railway) the term specific transportation costs (sk) is introduced. Basically, there are two methods to calculate this value, namely:

Method 1:

$$sk = \frac{CPV_k}{CPVQ}$$

whereby CPVk is the cumulative present value of the sums of investments and operating costs and Q is the CPV of the throughput both for certain period of time (say 20 years) and for a certain discount factor (say 10 percent) and both refer to a system length of 1000 km. This method is used in feasibility studies when it is necessary to take into account a certain throughput development and an investment program over the lifetime of the project.

Method 2:

$$sk = \frac{k_i + k_o}{Q}$$

whereby ki represents the annual capital expenses and ko represents the annual operating expenses, both refer to a system length of 1000 km, and Q is the yearly throughput.

2.11 The value of ki is derived from the investment (I) assuming a definite amortization time (say n = 20 years) and a definite interest rate (i) by applying the well known formula

$$k\text{i} = \text{I} \; \frac{i\,(1 + i)^n}{(1 - i)n - 1}$$

2.12 Method 2 is of a more general nature as compared to method 1, and has been used for calculating the specific transportation costs presented in this paper.

Analysis of Factors Which Influence the Transportation Cost for Petroleum Products in Pipelines

2.13 To calculate sk figures for product pipelines, specific parameters for the individual cost elements must be set to allow a consistent comparison of all costs involved. Furthermore, all factors which may influence the specific transportation costs must be analyzed in order to be aware of the impact that individual operating parameters may have on the overall economics of a pipeline transport system.

Capital and Operating Expenses

The breakdown of capital and operating expenses is shown in figures 2.1 and 2.2 for pipeline systems in Western Europe.

Figure 2.1: Capital Expenses

Capital and operating expenses:

The break down of the capital and operating expenses is shown in Fig. 4 for pipeline systems in Western Europe.

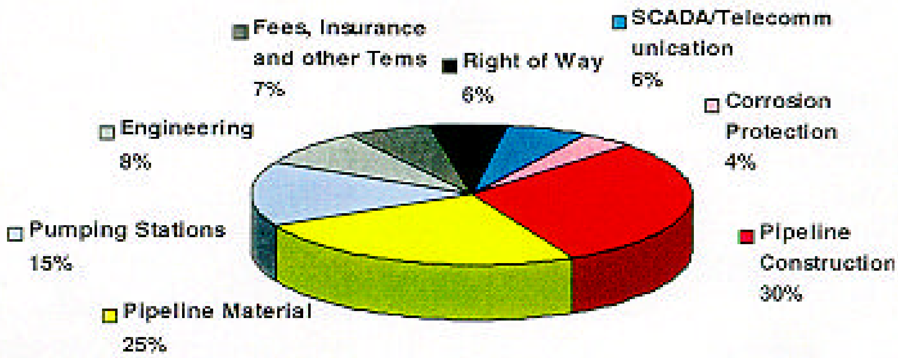
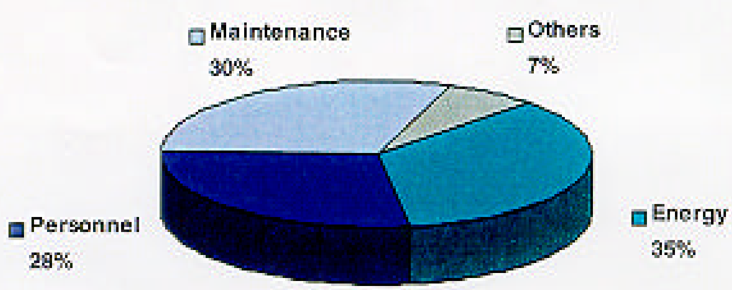


Figure 2.2: Operating Expenses



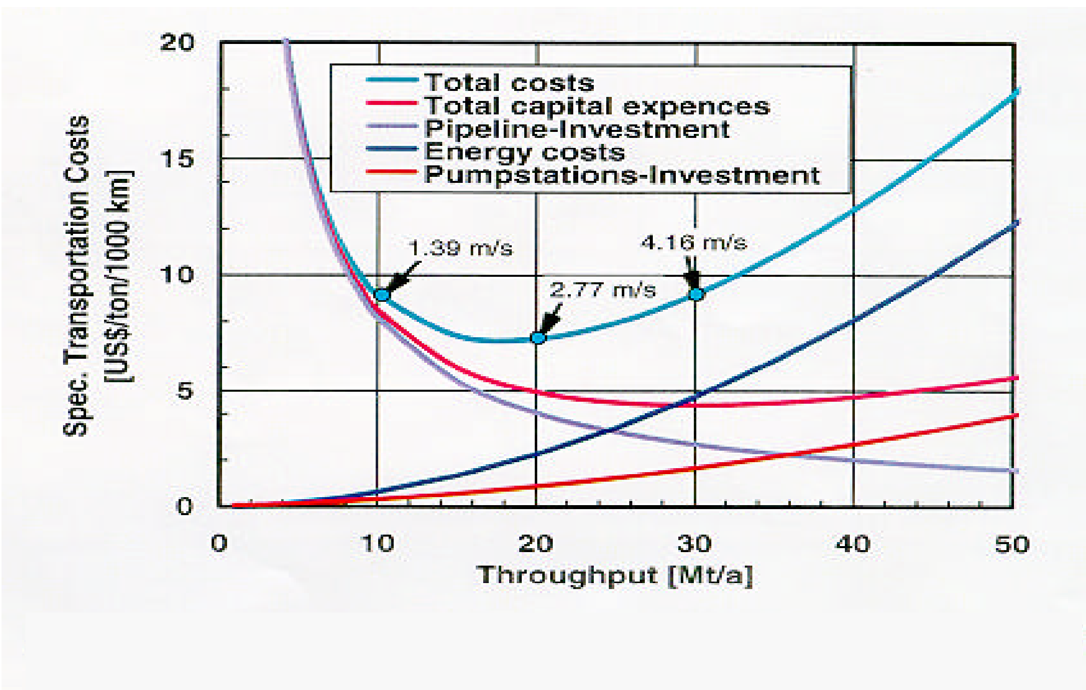
2.14 The largest investment item in a pipeline system is the mainline (pipe material, construction, and corrosion protection) which represents almost 60 percent of the total. The main options for reducing the investment are (i) the use of high strength steel and (ii) cost-effective construction methods.

2.15 The distribution of operating costs will depend on many factors. If the pipeline is operated at maximum throughput, then the energy costs might become the dominant item, especially if the hydraulic efficiency is low and the unit cost of energy is high. Other factors of influence are the degree of automation, the cost of the personnel, and the age of the pipeline.

Specific Transportation Costs for a Fixed Pipeline Diameter

2.16 The well-known curves for specific transportation costs versus throughput are shown under certain assumptions for a 24-inch pipeline system in figure 2.3. It is important to emphasize that such curves do not have general validity, but must be developed case by case, using the individual cost parameters of the project. The total cost curve indicates that the pipeline system has a certain throughput range for which the specific transportation costs reach a minimum (range of optimum operation). For the set of cost parameters used in this example, the 24-inch system could run competitively between 16 and 21 Mt/a.

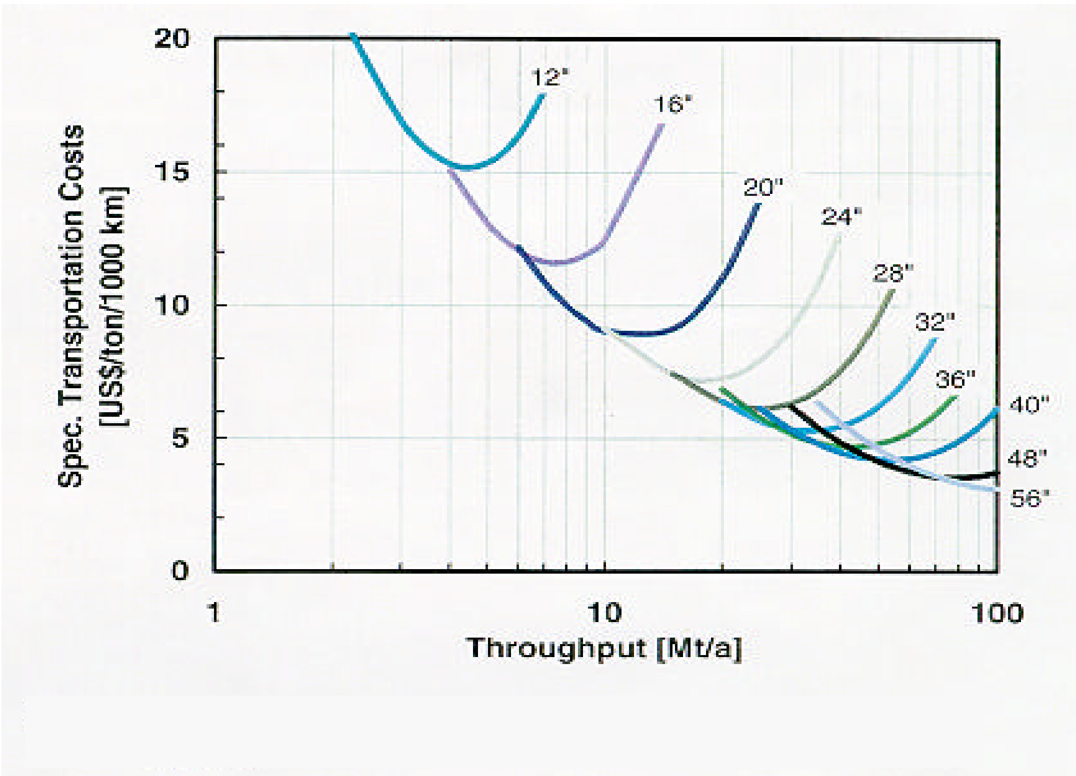
Figure 2.3: Specific Crude Oil Transportation Costs as a Function of Throughput for a Fixed Diameter



Specific Transportation Costs of Pipelines as a Function of Throughput and Diameter

2.17 In figure 2.4, the total cost curves for a series of commonly used pipeline diameters are shown for a wide range of throughput.

Figure 2.4: Specific Transportation Costs by Pipe Diameter

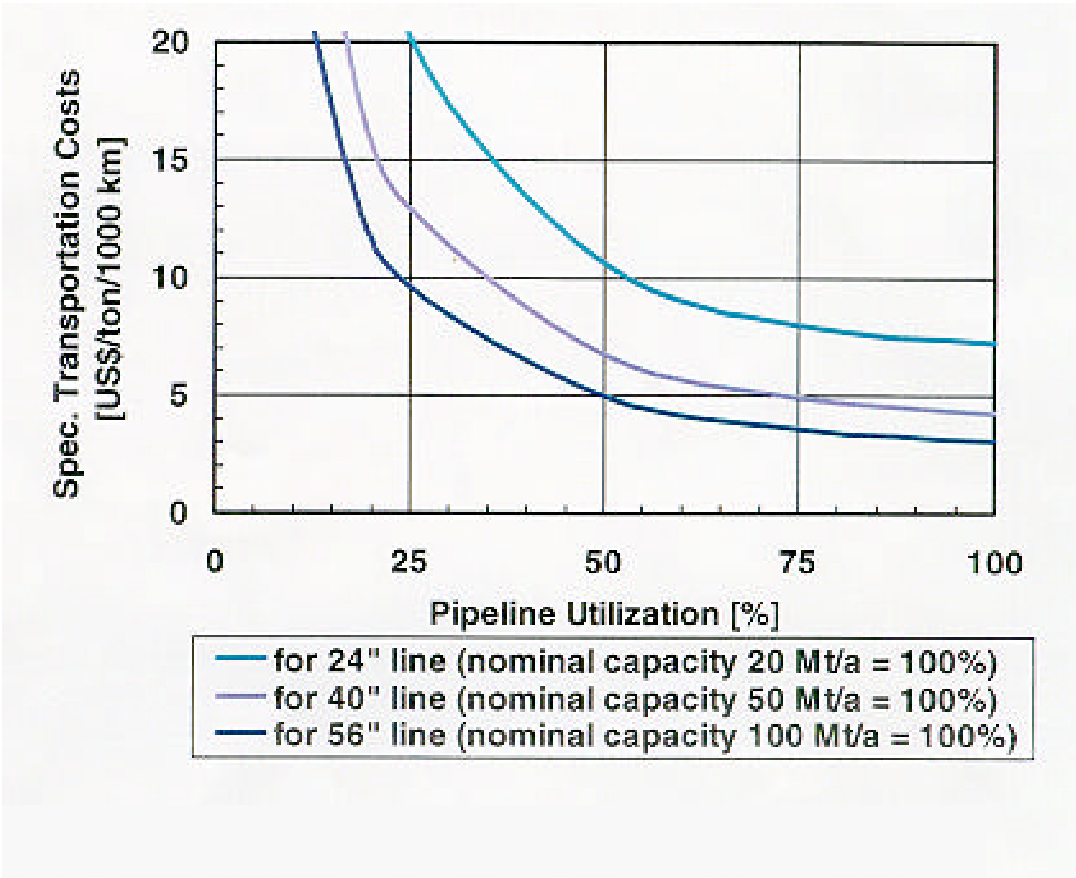


2.18 The cost curves in figure 2.4 above demonstrate clearly the economies of scale involved in transportation of petroleum product in pipelines (that is, “bigger is better”). For these cost curves, it was assumed that the pipeline utilization is uniformly 95 percent.

Influence of the Utilization Factor

2.19 A pipeline system is normally optimized during design for a nominal capacity which will be in the range of minimum transportation costs (see figure 2.4 for the optimum diameter for a given throughput scenario). Figure 2.5 shows the influence of the utilization factor, which is the ratio between actual and nominal throughput, on the transportation costs. Especially during the time of amortization, in which capital expenses are part of the fixed costs, the specific transportation costs increase rapidly if the system is not operated near its nominal capacity.

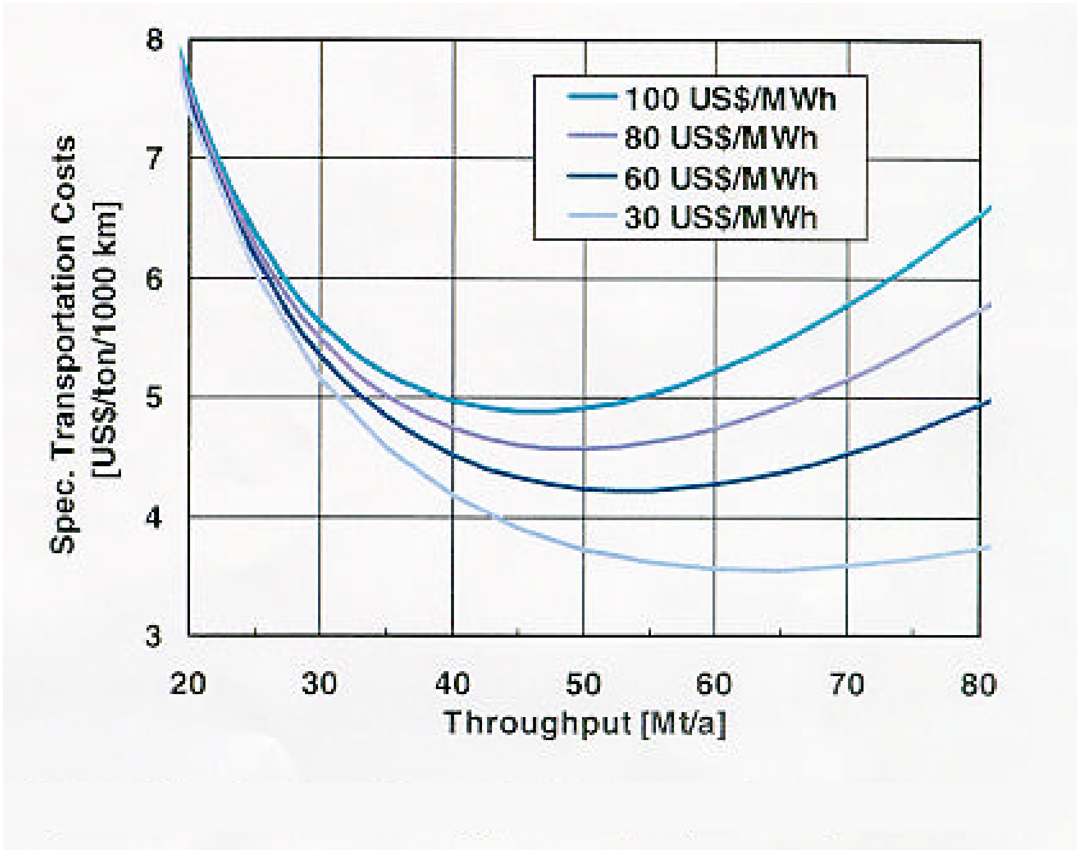
Figure 2.5: Specific Transportation Costs as a Function of the Utilization Factor



Influence of the Unit Cost of Energy

2.20 Figure 2.6 shows the specific transportation costs versus throughput of a 40-inch pipeline system for different unit costs of pumping energy, ranging from 30 to 100 U$/MWh. It is common sense that lower unit costs of energy will result in an increase of the optimum system throughput level. It is also evident that the unit costs of energy have a strong influence on the transportation costs, second only to the capital expenses.

Figure 2.6: Specific Transportation Costs as a Function of Energy Costs

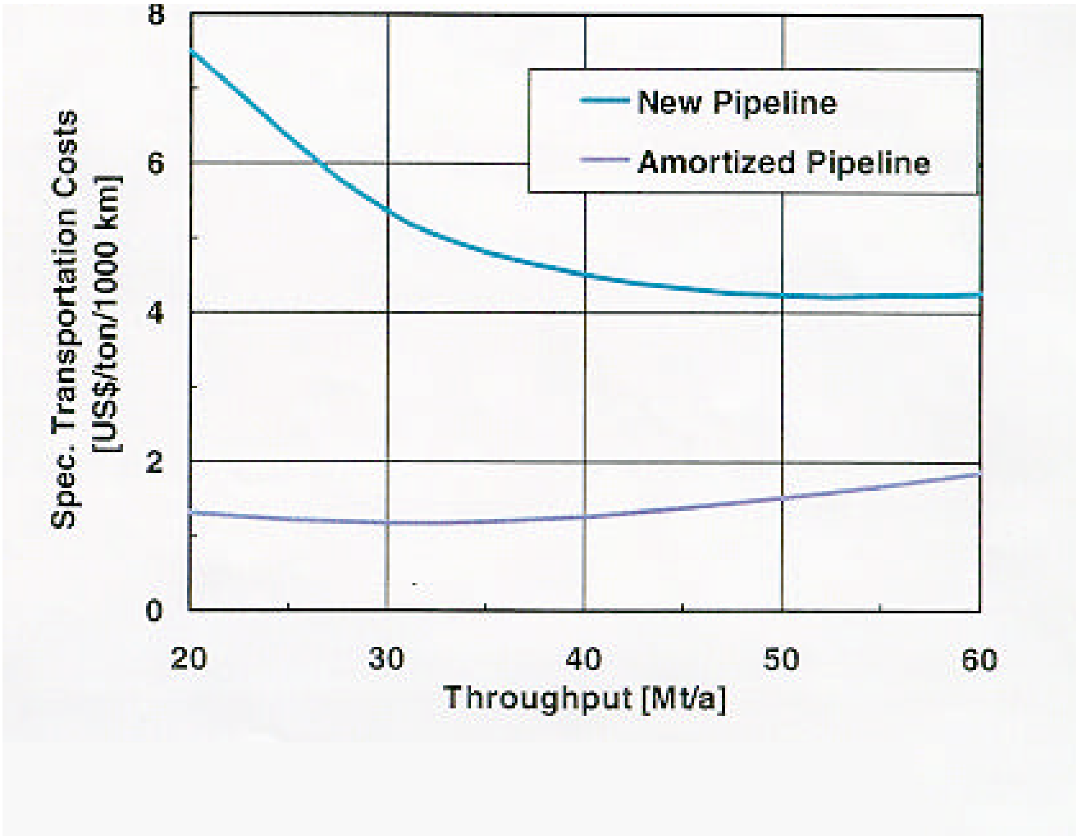


2.21 This underlines the advantages of so called "energy corridors," where a natural gas pipeline and a crude oil line are using the same route. In such a case, the pumps can be driven by gas turbines using the natural gas of the export pipeline, resulting in a low unit cost of energy and high hydraulic efficiency by the possibility of speed control.

Influence of Amortization

2.22 A pipeline which has passed its time of amortization and which has been kept in good condition becomes very competitive. This is shown in figure 2.7 by comparing the cost curves with and without capital expenses. Even if the costs for preventive maintenance increase, the transportation costs drop below 50 percent as compared to the time during amortization.

Figure 2.7: Effect of Amortization on Specific Transportation Costs



2.23 This effect can be used by operators of existing pipelines to offer available capacities at very competitive prices. The profit margin may be used to modernize the system or to expand it for increasing the throughput, if there is market for it.

Transport by Railway

2.24 Railway systems are, in some cases, the only means of petroleum transport. Many railroads in SSA countries have behaved as monopolies and have refused to accept liability for performance and product losses due to theft. Other inefficiencies result from inadequate rolling stock, poor operating conditions, lack of maintenance, and complete absence of an information system to schedule delivery and track the stock. Because of this, operating costs, as well as the risk of catastrophe for the sector, increase.

2.25 Governments must be willing to force a change in attitudes in the public sector and to provide infrastructure support to achieve an efficient market.

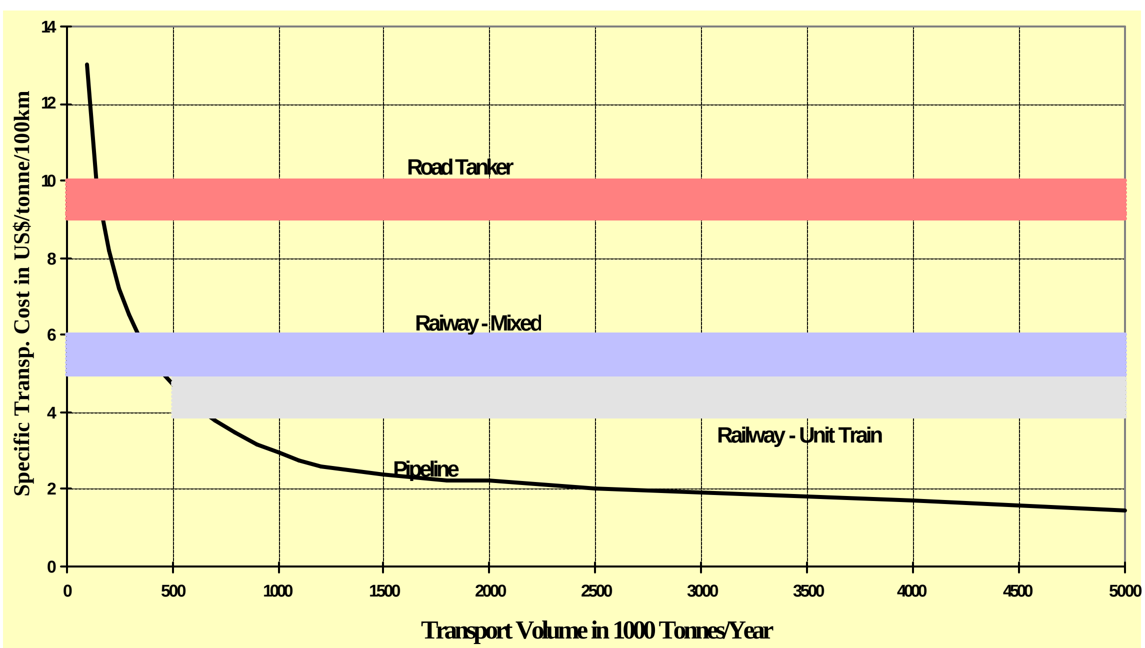
2.26 South Africa has a fairly well-run railway network which extends into Botswana and Zimbabwe. However, most railway systems in the SSA region, in particular the ones in Botswana and Zimbabwe, frequently do not operate because of poor maintenance or damage by natural disasters.

2.27 In such cases, petroleum transport reverts back to road tankers which lead to: (i) a significant increase in transportation cost; (ii) continuous disruptions in supply patterns; (iii) extensive damage to the existing road infrastructure, due to use of heavy trucks; (iv) a significant increase in road accidents; and (v) an overall reduction in supply security.

Transport by Road

2.28 Transport by road is the most common mode for petroleum products in SSA, as the infrastructure for rail or pipeline generally is not very developed. Transport by road tankers is also the least economical mode of transport. However, since private sector involvement is willing to accept liability for performance and losses, transport by road becomes competitive compared to rail transport. Inefficiencies result from poor road conditions and higher rates of road accidents, resulting in more pollution.

Figure 2.8: Comparison of Typical Petroleum Transportation Costs (Benchmark Cost)



It should be noted that these are economic costs only, and no margin for profit has been added.

2.29 Figure 2.8 shows that the specific transportation cost via pipeline decreases with increasing transport volume whereas product transport by road or railway is not dependent on the transport volume.

2.30 Figure 2.8 also shows that the pipeline option becomes competitive once transport volumes are above 700,000 tons per year and, with a 3 MTA transport volume, the specific transportation costs using a pipeline can be as low as one-fifth of the transport costs using road tanker.

Determination and Regulation of a Fair Transportation Tariff

2.31 Most economies in SSA are too small for effective competition in the petroleum transport sector; therefore, a regulatory framework for determination of a fair transportation tariff must be in place.

2.32 The pricing formula for the calculation of a transportation tariff must allow for a cost recovery element and a return on assets. It is necessary to compare a return on assets with those in other countries, for example, South Africa, where the allowed after-tax return is about 10 percent. Comparisons must be used with caution, as some countries represent higher risks than others, and companies operating under high risk deserve access to higher returns.

2.33 To develop a transparent pricing mechanism for the transportation of petroleum products, governments should be encouraged to consider the following measures as a minimum to ensure that the transportation for petroleum products will be rationalized to the extent possible:

?? The permitted return should be compared with other countries with a similar risk factor. Caution must be taken in the comparison to ascertain whether returns are real or nominal—that is, adjusted for inflation or not—so that in inter-country comparisons, an appropriate adjustment is made for inflation. The allowable return on assets should be reviewed reasonably often, perhaps every three to five years.

?? Also, there must be a clear incentive structure for continuous rationalization, so as not simply to pass the cost on to the consumer.

?? Assessment of the transportation part of the petroleum product price buildup in comparison to other countries should be done periodically to verify competitiveness.

?? Comparison of actual transportation costs with benchmark costs must be carried out in order to identify any potential for efficiency improvements, and to prevent abusive tariff pricing practices.

3

Risk Mitigation for Foreign Investors in the Petroleum Transport Sector

Protection for Private Investors by the General Framework for Private Investment

3.1 The need for private investment to realize the full potential of an efficiency increase in the petroleum transport sector of SSA is beyond dispute. Estimates of the total investment requirements in improvements in the petroleum transport infrastructure for SSA countries range between US$450 and US$650 million. These capital requirements are far greater than the amounts the governments could mobilize on their own account. Attracting such volumes of private investment into the landlocked and conflict-ridden SSA countries, which are inexperienced in market economics, is a massive policy challenge that has only begun to be addressed.

3.2 The petroleum transport sector (and, most likely, all other sectors as well) of SSA countries, however, are likely to be trapped in a low-growth scenario, unless they meet this challenge. Any sustainable growth strategy for these countries largely depends on their capacity to obtain financing or bank guarantees that would enable the infrastructure investments required to lower the cost of the petroleum supply.

The Limits of State Companies

3.3 State companies in SSA act as both the principal and agent. There seems to be no difference between the state's role as an investor and its role as a sovereign entity (for example, granting the rights to build pipelines and to operate them under nondiscriminatory conditions). An important factor here, however, has been that, in the absence of independent controls, the state company has sole command of a number of different roles, and these are, at times, incompatible. Typical problems include the following:

- ?? The efficiency of state companies is usually measured by purely physical factors, such as output. Market orientation, financial performance, and consumer preferences are mostly ignored.

- ?? Most state companies are not subject to comparison with directly competitive private enterprises. Thus, it is often not accurately assessed by the Ministries of the Treasury as to what extent governments are subsidizing inefficient operations. There is a risk that revenues are not transparently reported in the state budget, and that they may be spent inefficiently for political purposes or may even simply disappear in the form of corruption.
- ?? In regimes dominated by state enterprise, regulatory implementation and the control of health, safety, and environment protection are in the same hands.
- ?? With state companies often having an exclusive concession or monopoly, consumers typically have no viable commercial alternatives to the goods and services provided by the state company.

3.4 The lack of separation of the sovereign role from the commercial role makes the industry too vulnerable to noncommercial considerations that ultimately lead to distortions of the economy and to overall economic inefficiency.

3.5 This is particularly apparent in the area of financing, where projects involving a state company necessarily mix the sovereign and commercial risks of projects. A state company might get slightly better financial terms, because a state itself can provide a sovereign guarantee. The state’s financing capacity, however, may become so constrained by the borrowing of its state companies that the state cannot secure financing for other projects in the social sectors, that is, education, where the state can and should play a predominant role.

3.6 The tendency is, therefore, to disconnect the sovereign role of the state from commercial activities, to give the state back its sovereign functions, and leave the commercial activities to private investors.

The Interests of Governments and Private Investors

3.7 The relationship between the government and private investors must be well considered if both sides are to achieve their objectives. On the private investor’s side, the primary objective is to earn a profit proportionate with the risks taken in the venture. Furthermore, investors must find the opportunity to develop and operate transport infrastructures that are attractive compared with potential investments in other states or sectors. On the government’s side, the objectives are to protect the wellbeing of its citizens, improve economic prosperity, keep the economy supplied with low-priced products, maintain the public order, guard sovereignty, and return a maximum of revenues to the state budget.

3.8 The government needs to shield its citizens, according to international standards, against the negative impacts of economic activities. These potential impacts include not only the standard concerns for health, safety, and environment, but also concerns for protecting indigenous peoples and aspects of the national cultural heritage. Investors will have to accept the prevailing standards of protection, and they must be prepared to include the costs of meeting those standards into their calculations. At the same time, investors will also want the rules and standards for protection to remain relatively constant, or at least predictable, in line with the development of international standards. Investors will also evince the same desire for regularity with regard to liability resulting from accidents.

Expectations of Governments

3.9 Obviously, most governments will insist on earning revenue from any activities. As a baseline, such revenues are realized in a way similar to the state's practices for other economic activities—that is, usually in the form of a profit-related tax or a consumption-related tax. When it comes to ceding monopoly rights vested in the state or stemming from the sovereignty of the state, the state would usually ask to share the rent stemming from granting such monopoly. This will hold especially with regard to exploitation of finite mineral resources, but it also will apply to the rights to use the national territory for the laying of a pipeline and for any exclusive or nonexclusive concessions.

3.10 The interests of the state and also its position to achieve these interests will be different depending on whether it is a producing, a transit, or a consuming state, or a combination.

Expectations of Private Investors

3.11 Private investors may likewise have incentives, motivations, and obligations in undertaking involvement in an oil or gas project. Incentives for private investors are: (i) finding the project commercially attractive, taking into account all of the risks, compared with opportunities in other countries and sectors; and (ii) strategic positioning in view of future projects. Furthermore, private investors require protection for (i) right of property, rule of law, stability, and predictability of health, safety, and environment (HSE) requirements and economic rules, and clear regulatory regime; and (ii) protection of the investment and its operation against unlawful actions, that is, no interference by the state

3.12 The interests and expectations of the governments and the private investors are somewhat asymmetric over time. Before the project begins, the governments must offer competitive conditions to attract the investor in competition with other states or sectors, whereas the investor is free to invest or not. Once an investment is irreversibly linked to a country, however, as it is in the case of transport infrastructure investments, the investor becomes vulnerable to obsolescent bargaining by the host country and needs effective protection against it.

3.13 The following two sections discuss what arrangements are possible between a state and private investors through which the state can show its commitment to noninterference and to abiding by its own rules.

Protection for Private Investors by the General Framework for Private Investment

3.14 The presence of a credible and functional general framework for commercial investors within a state is an important source of assurance to private investors. Such a framework can be fixed with host government agreements between a sovereign state and a private investor or between individual countries with the introduction of intergovernmental agreements. In other regions of the world, in particular in the Caspian region, several countries have established inter-governmental agreements using international law experts to demonstrate their readiness for foreign investment. Private investors who have successfully negotiated a host government agreement for transit of large oil and gas pipelines followed this practice. Such events have triggered investments in the oil and gas sector worth over US$10 billion.

Guidelines for a Regulatory Framework That Attracts Foreign Investment

3.15 It is especially important for landlocked SSA countries to demonstrate good behavior and fiscal prudence for investors. This requires better fiscal management and, in particular, sector protection from the government temptation to increase unilaterally the tax obligations for private sector investors.

3.16 Parallel to fiscal reform, SSA governments need to reduce the wasteful, poorly targeted subsidies currently being channeled to inefficient state-owned enterprises involved in the transportation of petroleum product by railways or road tankers. This quasi-fiscal resource flow tends to be underestimated and could achieve much greater poverty alleviation impact if allocated more deliberately and transparently. This would also help create a more reliable energy supply and reduce opportunities for rent-seeking.

Policy reforms should include creation of competitive petroleum transportation schemes and regulation of natural monopolies (such as pipelines) to avoid excessive tariffs.

3.17 Legal reforms, which enhance property rights, environmental management, and labor protection, as well as judicial reforms to improve enforceability, would help mitigate investor risk and increase the host country benefits from investment. Strong civil codes and other legislation underpinning contractual rights, enhanced labor law, and improved legislation on environmental standards and liabilities are also necessary. For pipelines, in particular, it may also require improvements in land legislation, transparent guidelines for expropriation, and compensation for land owners and land users.

3.18 Building the capacity of institutions that interface with the hydrocarbons sector can mitigate political risk. Most SSA countries have not yet succeeded in establishing small expert teams with a good understanding of the regulatory framework, which is required to attract private sector investment in petroleum transport. The limited understanding of government agencies in other sectors has not always been well disseminated to the multitude of other government institutions which come into contact with the petroleum transport sector. In addition, the absence of experienced officials has meant that those with experience tend to combine regulatory and commercial functions, which should ideally be divided to prevent conflicts of interest.

3.19 Perhaps the most important way to mitigate political risk is to negotiate balanced agreements at the outset, which allocate risk and reward appropriately between host governments and foreign investors. In the midst of geopolitical pressures and uncertainty about competing projects, this is often difficult to achieve in the petroleum transport sector. It is made more difficult by the often short-term horizons of political decision-makers within the SSA countries. Those short-term factors can overshadow the fact that infrastructure projects for the petroleum transport sector often have a potential life of several decades. Agreements which are not designed to have a good chance of enduring changes of government and major economic fluctuations can prove very disruptive to a host country's political life and investment climate, as well as to the fortunes of the investor.

Risk Mitigation for Transit Pipelines

3.20 Risk mitigation for transit pipelines should include the following components:

- ?? Economic viability must have priority over strategic and geopolitical consideration.
- ?? Negotiation on transit arrangements should be carried out in a de-politicized environment.
- ?? Well-balanced transit agreements, which consider risk versus reward for all involved parties, must be concluded among the exporting, transit, and importing countries.
- ?? The legal and regulatory framework for transit pipelines must be in place.
- ?? It is necessary to explore alternative options for export routes and to identify "good" or "bad" transit countries.

3.21 Many cross-border or transit pipelines do not include risks which are not manageable by the private sector. In cases where pipelines involve transit through developing countries or transition economies, however, risk mitigation instruments from official agencies may be needed for the investor to mobilize sufficient private equity and commercial financing. Such official agencies include multilateral and bilateral development banks as well as export credit agencies. The risk mitigation instruments offered from those official agencies differ substantially. Bilateral financing organizations, such as export credit agencies often have the procurement of goods and services for the construction tied to its involvement and, as such, could introduce a third party with special interests into a trade and transit arrangement.

Risk Mitigation through Official Agencies

3.22 In some projects of petroleum transport infrastructure, the investment framework itself could mitigate risk adequately, allowing the investment to go forward. In other cases, particularly those involving transit pipelines, risk mitigation instruments from official agencies may be needed for the investments to be able to mobilize sufficient private equity, commercial financing, or private political risk insurance. Such official agencies include multilateral and bilateral development banks, as well as export credit agencies.

3.23 The aforementioned agencies can offer a range of risk mitigation instruments, such as direct loans, loan syndications, guarantees, equity, and insurance. The principal agencies active in the region, and offering private sector risk mitigation, include the World Bank Group, African Development Bank (ADB), Overseas Private Investment Corporation (OPIC), and export credit agencies (such as ECGD, JBIC, US ExIm, Coface, Hermes, EDC, and SACE).

3.24 Although the risk mitigation instruments differ substantially in scope and in scale, they are similar in one key respect: the involvement of public sector agencies can give a distinctive degree of protection to private investors–a so-called "halo effect." In essence, a government's breach of its obligations to foreign investors becomes, de facto or de jure, a breach of its obligations to foreign governments (either individually or collectively) and can have broad implications for that country's access to official financing and to capital markets. In the SSA region, where capital market access is fragile and relations with foreign donor governments are very important, the halo effect can be a key value. It should not be seen, however, as a substitute for reducing risk through institutional, policy, and legal reform.

3.25 The significance of transit, in particular, for hydrocarbon transport via cross-country pipelines has encouraged the search for stronger legal instruments to facilitate transit and bolster the legal security of pipeline and transit arrangements. A good example for such key legal instruments is the 1994 European Energy Charter Treaty (ECT). It has two main elements reinforcing the legal value of pipeline contracts: first, it provides for protection of the property and contracts of foreign investors, bolstered by a direct investor-state arbitration right (Art. 10, Art. 26); second, it includes a novel obligation of member states to enable and facilitate transit, and to abstain from politically motivated disruption. The ECT, however, has only been signed by countries in Europe and Central Asia and would, at best, be considered only a legal guideline for non-signatory countries.

The Role of the World Bank Group

3.26 Specifically for transit pipelines, the World Bank Group offers very effective risk mitigation instruments, such as political risk guarantees. The World Bank Group is the only organization that (i) operates on a global scale; (ii) is impartial and has a unique relationship with governments and the private sector; (iii) has the size and institutional capacity required for large-scale infrastructure investments, such as regional pipelines; and (iv) develops a regional and multi-sectoral assistance strategy to ensure a balanced approach.

3.27 Furthermore, the Bank's role is not just to mitigate risk for the private investors, but to add value in order to (i) ensure that stringent social and environmental guidelines and best practices are applied; (ii) build capacity in the involved governments for appropriate legal and regulatory frameworks; (iii) use it as a vehicle to push for reforms in other sectors through conditionalities, and; (iv) introduce transparent procurement and anti-corruption policies.

4

Case Studies

Case Study 1: Southern Africa—Regional Petroleum Distribution System

Objectives

4.1 Angola, which is emerging as a major oil producer in the SSA region, along with Nigeria, is planning a new refinery on its territory. The objective of this case study is to make a preliminary economic evaluation of a proposed new petroleum transport infrastructure in an SSA region and to determine whether it has the potential to rationalize the transport of petroleum products in the southwestern part of the SSA region.

Background

4.2 For the purpose of this evaluation, "southern Africa" is defined as the region covering Angola, Namibia, Zambia, the western part of Zimbabwe, Botswana, and the northeastern part of South Africa. All these countries, except Angola, are net importers of petroleum fuels. South Africa imports most of its crude oil requirement for processing in its private refineries, with a total capacity of about 20 million tons per annum (MTA). Domestic consumption has already surpassed the available refining capacity, and very soon the country will become a net importer of white products. The options for South Africa in the future are between (i) importing finished petroleum products and (ii) importing crude oil and processing it in new refineries. At the moment, there are no firm plans for building new refineries in South Africa. Namibia, Zambia, Zimbabwe, and Botswana import their entire requirement of petroleum fuels. The southern Africa region, as defined above, is landlocked, and product movement to these areas from seaports is invariably expensive. Below is a comparison of the approximate landed cost of diesel in these areas as compared to the average landed cost in Western Europe.

Table 4.1 : Comparison Table for Landed Cost of Diesel

	Angola	*Namibia*	*Zambia*	*W. Zimbabwe*	*Botswana*	*NE of SA*	*Europe*
CIF sea port	168.50	169.50	166.50	168.50	169.50	169.50	151.50
Distribution	70.00	30.00	36.00	59.00	45.00	25.00	15.00
Total *	238.50	199.50	202.50	227.50	214.50	194.50	166.50

* Not included in this comparison are (i) local costs not related to transportation, and specific to the country; (ii) marketing and dealer margins; and (iii) government taxes and levies.

4.3 Angola has emerged as the second largest producer of crude oil (after Nigeria) as a result of private participation in oil exploration and production (about 35 MTA in 1996). On average, the Angolan Government's share of this is about 40 percent (about 14 MTA). All of these, except for about 2 MTA used for local refining, are exported by the producing oil companies. Currently, Angola is in the process of exploring possibilities for private sector participation for a world class export refinery in Luanda to process part of its own share of crude oil and obtain value added for its oil export revenue. The Angolan Government's idea, in this respect, seems to be logical and commercially viable if implemented strictly as a commercial proposition, with efficient private sector investment and management in operation for the following reasons:

?? The availability of relatively cheaper, low-sulfur crude oil at the site.

?? The availability of surplus associated gas as fuel for the refinery.

?? Owner transport cost to supply products in the SA region.

4.4 Currently, transportation to the landlocked areas of the SA region is partly by pipelines (in the case of Zambia and Zimbabwe only) and the rest by rail and road. For Zambia, a mixture of crude, condensate, and products are unloaded in Dar es Salaam, transported to the refinery in Ndola by pipeline and the products are delivered from the refinery terminal mainly by road. Under the ongoing IDA-financed project, a good portion of the products are expected to be transported to Lusaka by rail to reduce transportation cost. Zimbabwe imports its entire requirement as finished products at Beira in Mozambique and delivers it to Mutare and Harare by pipeline. For southern and western Zimbabwe, however, the products are transported by rail from Harare. Botswana gets its entire requirement by rail from Durban/Johannesburg. Namibia imports finished products in Walvis Bay and transports them to Windhoek by rail. The Transvaal region of South Africa gets products from Durban by rail. Inland areas in Angola get products by road from Luanda.

4.5 Under the product transportation scenario indicated above, it would be interesting to study the economic viability of constructing a regional white product (gasoline, dual purpose kerosene, and diesel) pipeline from Luanda in Angola to somewhere near Pietersburg in the Transvaal region of South Africa with tap-off branch lines to supply the central and southern part of Angola, Lusaka, and southern region in

Zambia, Windhoek in Namibia, Bulawayo, and the southern regions in Zimbabwe and Botswana. The construction of such a regional product pipeline would be contingent on construction of the export refinery indicated above. This aspect will be dealt with separately, and the two projects will be treated independently of each other.

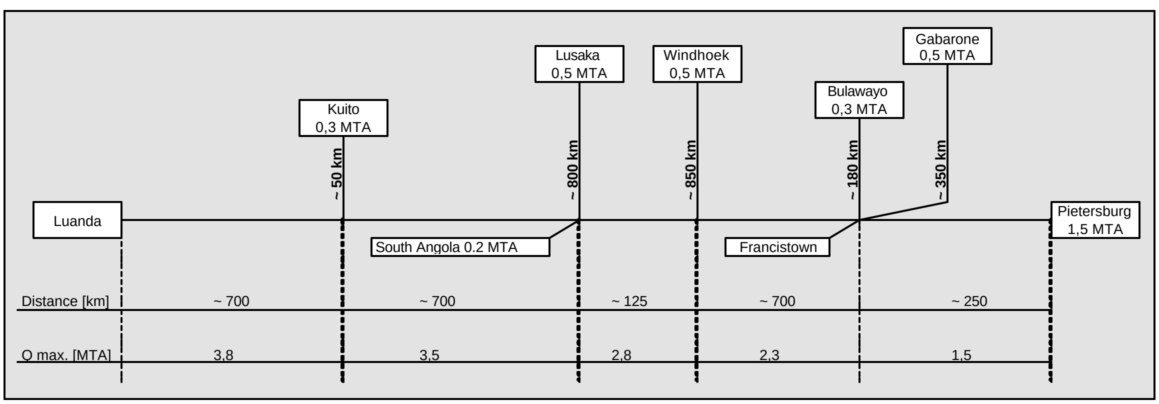
Estimated Consumption of White Products in the SA Region

4.6 Data for region-wide consumption of white products in the above-mentioned countries are not readily available. For the purpose of the proposed pipeline study, the following quantities are assumed for each country, on the basis of available information.

Table 4.2: Gasoline, DPK, and Diesel (Million Tons / Year)

Central and southern Angola	0.500
Lusaka and southern Zambia	0.500
Windhoek and central Namibia	0.500
Bulawayo and southern Zimbabwe	0.300
Botswana	0.500
Transvaal region of South Africa	1.500
TOTAL	**3.800**

Figure 4.1: Schematic Overview of the Proposed Product Distribution System



Preliminary Economic Evaluation of the Project Concept

4.7 The main objectives of the proposed pre-investment study are to evaluate the merits of several possible configurations for the pipeline (mainline as well as branch lines), and to evaluate the optimum configuration, which would become the basis for a detailed feasibility study later, if the concept were found to be attractive as a result of the pre-investment study. In order to test the merits of the project concept, based on available information and a number of assumptions, a preliminary desk study was conducted.

4.8 Since there are numerous ways to import products into various areas in the SA region, the following assumptions were made for the preliminary evaluation:

(a) The cheapest source of white products continues to be Mediterranean refineries, and the source pricing will be based on free on board (FOB), Mediterranean (Italy) as published in the daily Platt's Oilgram.

(b) Ocean freight and insurance for white products from the Mediterranean in a 30,000 DWT tanker were assumed to be US$18/ton for Durban, US$15 for Beirra, US$17 for Luanda and US$18/ton for Walvis Bay in Namibia.

(c) For Zambia, the mixture of crude oil, condensate, and products come from the Arab Gulf in 50,000 DWT tankers, and the freight to Dar es Salaam is assumed to be US $10/ton.

(d) For Zambia, the cost of pipeline transportation from Dar es Salaam to Ndola is US$21/ton; the refining cost in Ndola is US$22/ton; and rail transport from Ndola to Lusaka is US$15/ton.

(e) The cost of (i) rail transportation is assumed at US$0.06/ton-kilometer, (ii) road at US $0.10/ton-kilometer, and (iii) pipeline at US$0.02– US$.06 per ton-kilometer (depending on the mainline or the branch line).

4.9 The following two scenarios were considered to compare their relative merits against the current mode of product transportation to different areas in the SA region:

4.10 Scenario I: Transport of white products originating in Luanda via a main trunk pipeline up to Pietersburg, with tap-off points and branch pipelines to Kuito in Angola, Lusaka, Windhoek, Bulawayo, and Gabarone.

4.11 Scenario II: Transport of white products originating in Luanda via the main trunk line up to Pietersburg, with further transport of the products from the tap-off points by rail or road to various consuming centers as indicated in Option I.

Table 4.3: Calculation Table for Preliminary Economic Comparison of Transport Scenarios

Route	Transport by Pipeline (Mainlines)								
	Market Volume [MTA]	Total main line length [km]	Specific Transp. Cost [USD/ton/km] Section 1	Specific Tr. Cost [USD/ton/km] Section 2	Specific Tr. Cost [USD/ton/km] Section 3	Specific Tr. Cost [USD/ton/km] Section 4	Specific Tr. Cost [USD/ton/km] Section 5	Transp. cost in main line [USD/Ton]	Transp. cost in main line [MM USD]
Luanda - Depot Kuito	0.3	700	0.02					14.000	4.20
Luanda - Branch point Lusaka	0.7	1400	0.02	0.0205				28.350	19.85
Luanda - Branch point Windhoek	0.5	1525	0.02	0.0205	0.021			30.975	15.49
Luanda - (Francistown) Bulawayo	0.3	2225	0.02	0.0205	0.021	0.022		46.375	13.91
Luanda - (Francistown) Gabarone	0.5	2225	0.02	0.0205	0.021	0.022		46.375	23.19
Luanda - Depot Pietersburg	1.5	2470	0.02	0.0205	0.021	0.022	0.026	52.875	79.31
Total	**3.8**								**155.95**

Route	Transport in Branch Lines					Transport by Rail/Road					
	Market Volume [MTA]	Length [km]	Specific Transp. cost [USD/ton/km]	Transp. cost in [USD/Ton]	Transp. cost in branch line [MM USD]	Specific Transp. cost [USD/ton/km]	Transship. cost [USD/ton]	Transp. cost by rail/road [USD/Ton]	Transp. cost by rail/road [MM USD]	Scenario 1 Transp. cost in [USD/Ton]	Scenario 2 Transp. cost in [USD/Ton]
Branch point - Lusaka	0.5	800	0.045	36	18.000	0.10	0.740	80.74	40.370	64.350	109.090
Branch point - Windhoek	0.5	850	0.045	38.25	19.125	0.10	0.740	85.74	42.870	69.225	116.715
Branch point - Bulawayo	0.3	180	0.063	11.34	3.402	0.05	0.740	9.74	2.922	57.715	56.115
Branch point - Gabarone	0.5	350	0.045	15.75	7.875	0.05	0.740	18.24	9.120	62.125	64.615
Total	**1.8**				**48.402**				**95.282**		
Total Cost Scenario 1	**204.347**	**MM USD**									
Total Cost Scenario 2	**251.227**	**MM USD**									

Route	Calculation for Current Transportation Cost										
	Ocean Transport			Inland Transport by Pipe/Rail/Road						Total	
	Market Volume [MTA]	Ocean Transp. Cost [USD/ton]	Handling Charges [USD/ton]	Cost of Pipeline Transport [USD/ton]	Mode of Transport	Length of transport [km]	Specific Transp. cost [USD/ton/km]	Inland 'Transp. cost [USD/ton]	Total Inland Transp. cost [MM USD]	Total 'Transp. cost [USD/ton]	Total cost of transport [MM USD]
Luanda - Kuito	0.3	17.00	9.00		Road	750	0.10	75.00	22.500	101.00	30.300
Luanda - Depot South Angola	0.2	17.00	9.00		Road	1400	0.10	140.00	28.000	166.00	33.200
Dar - Ndola - Lusaka	0.5	10.00	9.00	43.00	Rail	300	0.05	58.00	29.000	77.00	38.500
Walvis Bay - Windhoek	0.5	18.00	9.00		Rail	430	0.05	21.50	10.750	48.50	24.250

Beira Harare - Bulawayo	0.3	15.00	9.00	39.00	Rail	500	0.05	64.00	19.200	88.00	26.400
Port of Durban - Gabarone	0.5	18.00	9.00		Rail	1080	0.05	54.00	27.000	81.00	40.500
Port of Durban - Pietersburg	1.5	18.00	9.00		Rail	950	0.05	47.50	71.250	74.50	111.750
Total	3.8								207.700		**304.900**

Conclusions from the Preliminary Evaluation of Case Study 1

4.12 The details of the calculations are shown in table 4.2 above. The total cost of transportation of 3.8 MTA of white products by the current mode of transportation to various locations in the SA region amounts to US$304.9 million per year. Compared to this, Scenario I would cost US$204.35 million and Scenario II would cost US$251.23 million. Scenario I is clearly the better option, and a detailed pre-investment analysis of Scenario I and its possible variants is recommended.

Case Study 2: Regional Petroleum Transport System for West Africa, Originating in Nigeria

Objective

4.13 Nigeria's crude oil and product pipeline infrastructure is already extensive and covers most of the country. Its current operation and performance, however, have been unable to meet the needs of the market. Pipeline configuration, operation, maintenance, and management all need to be improved. The objective of this case study is to identify those aspects of the subsector which are leading to its underperformance, and to propose rationalization measures, in particular, to promote private sector investment to optimize the use of the existing infrastructure for the country and perhaps for its landlocked neighbors.

Background

4.14 The oil industry has dominated the country's economy since the start of large-scale exploitations in the 1960s and 1970s. Nigeria has substantial reserves (20 bn bbl) of premium crude oil. Crude oil revenues have reached US$19.1 bn, which accounts for about 30 percent of GDP. According to data from the International Energy Authority, 80 percent of this total is from government revenues and 90 percent is from foreign exchange earnings.

4.15 Historically, Nigeria's oil has been produced in joint ventures of foreign oil companies (FOCs) with the state-owned Nigerian National Petroleum Corporation (NNPC). NNPC, however, has frequently failed to provide its share of maintenance and other obligations. For new discoveries, FOCs are entering into production sharing agreements with the GoN. Production Sharing Agreements (PSAs) relieve the state from risky exploration costs and large-scale investments in production facilities and allow the costs to be recovered with future production.

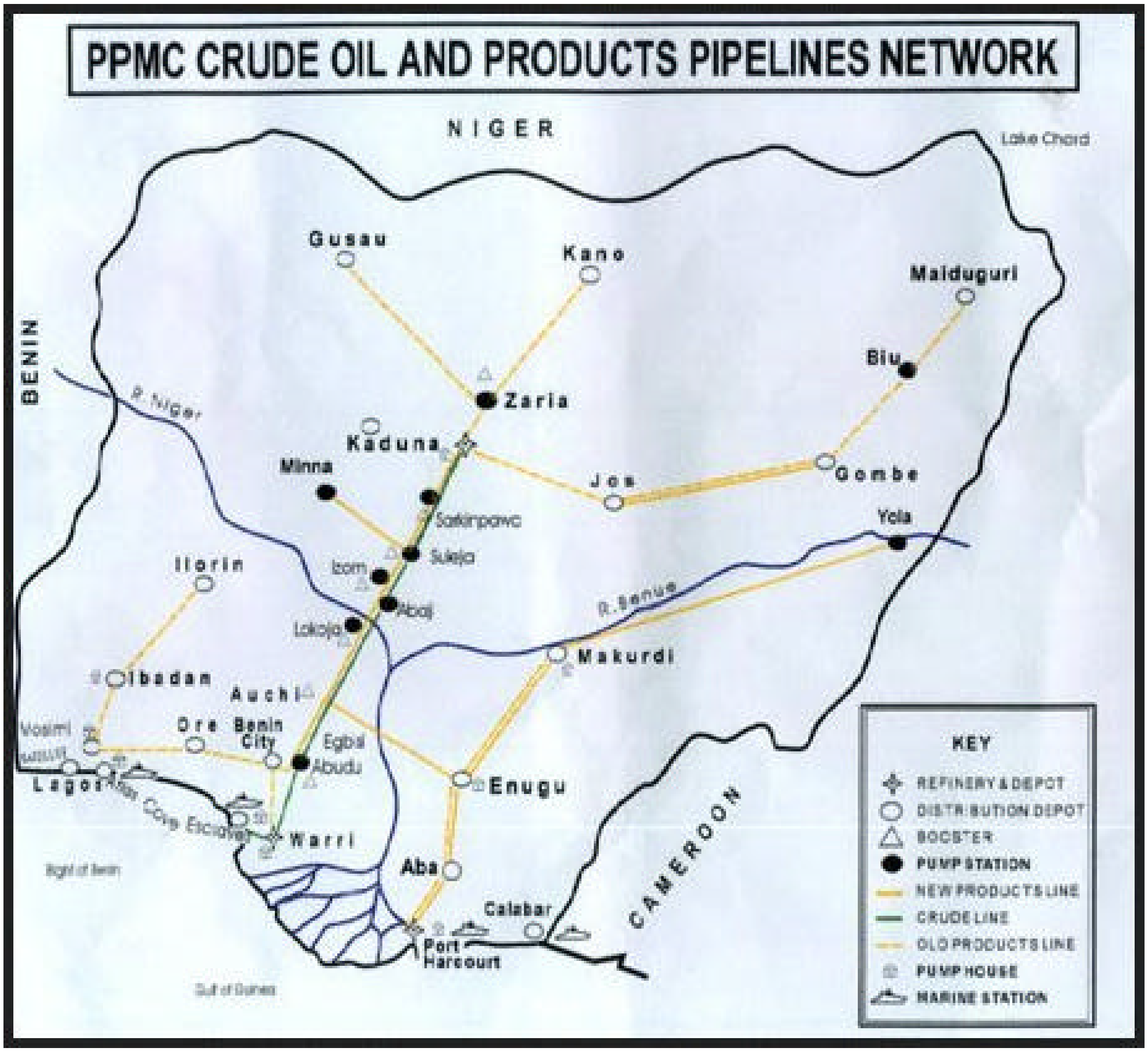
4.16 The GoN remains focused on the revenues from oil exports, and wants to raise production from a current level of around 2 million bbl to even 5 million bbl annually. In recent years, the focus of production—in particular, production from FOCs—has been shifted from the swamps of the Niger delta to off-shore discoveries in the sector's attempt to free itself from the problematic contractual relationship with the GoN and its dealings with disgruntled indigenous communities in the Niger delta, who feel neglected despite the overwhelming contribution of the Niger delta to the GoN's export revenues.

4.17 The high levels of production, however, have brought little relief for ordinary Nigerians, who have suffered decades of domestic fuel shortages, stemming, in part, from the inefficiencies of the country's refineries and transport infrastructure.

Petroleum Transport Infrastructure

4.18 Nigeria has an extensive crude oil and products pipeline system, linking the ports, the main oil fields, the three refineries, and the main demand centers, including extensive crude and product storage along the system. The entire pipeline infrastructure is operated and managed by Products and Pipeline Marketing Company (PPMC), which is a state-owned entity. The total length of the pipeline system is about 4,000 km (roughly, 3,400 km of product pipelines and 600 km of crude oil pipelines), of which about 2200 km were built after 1993/94. Nigeria also has 23 storage depots for petroleum products throughout the entire country, with a total storage capacity of 1,970,000 cubic meters. The pipeline system also has a number of smaller branch lines bringing products to storage depots (for example, Yola, Maiduguri, Gusau) nearer to the borders with other countries (that is, Niger and Cameroon). The Nigerian demand in those areas is relatively small, however, and the rationale for the investment is questionable. The main demand centers are Lagos, Kaduna, Rivers, Delta, and Oyo, absorbing more than one-half of the total demand. Lagos alone comprises about two-thirds of the total fuel oil consumption in Nigeria.

Figure 4.2: Overview Map of the Existing Petroleum Product Pipeline and Distribution System



4.19 PPMC's current operation and performance, however, have been unable to meet the needs of the market. Pipeline configuration, operation, maintenance, and management all need to be improved. Long-distance transport of petroleum in Nigeria is mainly by pipeline (about 60 percent) with the other 40 percent by road. The pipeline proportion should be higher, but PPMC has been inefficient in maintaining its facilities adequately for many years. Widespread leakages, including those caused by sabotage, have been recorded over a prolonged period.

4.20 Evidence is everywhere of the deteriorated condition of the pipeline infrastructure system. The need for a well-structured investment program to realize the full national and regional potential of the existing petroleum transport infrastructure is beyond dispute. Recent reports by potential investors suggest that investments in a magnitude of over US$200 million are required. Nigeria is the world's 9th largest crude oil exporter. However, given the massive challenges for the GoN in the social sector and other (non-extractive) industry sectors, the GoN's financing capacity may become constrained by the borrowing of its state company PPMC for further infrastructure investments which are much better designed and managed by the private sector.

4.21 Attracting such volumes of private investment into politically unstable countries, such as Nigeria, which are inexperienced in market economics, is a massive policy challenge that has only begun to be addressed. The petroleum transport sector, however, and, most likely, all other sectors as well, are likely to be trapped in a low-growth scenario, unless they meet this challenge.

Required Policy Changes in the Petroleum Transport Sector

4.22 The present system is for the PPMC to own the product and sell it to marketers at the storage depots. PPMC goes further and has an extensive set of requirements before allowing the retailer to obtain the product from the pipeline, the sort of list that a license issuing agency, such as the ministry or the regulator, might require. In a competitive modernized system, there is no need for the pipeline to act as a middleman, that is, buying oil at the refinery and selling it at the depot, nor should the pipeline act as a regulator. Marketers should buy from the refinery or import directly and pay a tariff for pipeline transportation and storage in the depots, in the same way as they pay a tariff for road transport. In Nigeria and elsewhere, it is normal practice that, as long as the products comply with specifications, it does not matter that the products of different purchasers get commingled; this happens wherever common carrier pipelines transport petroleum products.

4.23 Part of ensuring a level playing field and equal treatment for all marketers is for the pipelines and related storage to be operated as a public utility. Ideally, the pipelines and depots would be operated by a storage and pipeline company selected by an open tendering process. The selected company would need to carry out a program to rationalize the entire operation and invest to bring the pipeline and storage system up to an acceptable technical standard. The selected company, therefore, would need a long-term engagement to have the time to recover the necessary expenditures. There are a small number of specialized storage and pipeline companies who might be interested in investing in Nigeria under the right circumstances. Letting a marketer be the pipeline operator would have conflict-of-interest implications, such as giving priority to his own products and deliberately delaying access for a rival competitor. The alternative is for the operator to be a joint venture that effectively includes all refiners and marketers, but the large number of small marketers makes this joint venture concept difficult in Nigeria's situation.

Pipeline and Depot Tariffs

4.24 The crude and product pipelines, the depots, and any import facilities, by definition, are de facto monopolies. They have spare capacity, but are not designed in a way such that they could provide competing routes, and new pipelines would be a waste of public money. Although the government may not interfere if a new investor came forward, it is unlikely that a private investor would find it interesting to invest in a competing transportation system. As such, the tariffs charged should be controlled by formula and be closely monitored by the regulator. The so-called "cost plus" tariffs would be nondiscriminatory and set at a level to cover the costs of the operator, provided the operations are efficient, and include a reasonable rate of return on investment. A reasonable rate of return on investment should consider country-specific risk factors. The most relevant form of tariff is one that charges for the capacity that has been reserved by the shipper, and an additional charge per ton and kilometer transported. There would, in addition, need to be a storage fee and a fee for transshipment. Tariffs as in Kenya, Zambia, and Zimbabwe are much simplified because of the monopolistic approach in these countries. The Zambia tariff at US$23 per ton for 1800 km of mainly 8-inch pipe is a useful comparator—those in both Kenya and Zimbabwe are exceptionally high in recognition of past lack of competition in contracting. Best practice in pipeline tariffs is to set a volume/distance related tariff for the pipeline and additional charges for storage and transshipment on a cost-plus basis. The largest integrated pipeline system is that in the former Soviet Union, where tariffs are distance–related, with additional charges for storage and transshipment.

Transport Cost Equalization

4.25 Nigeria equalizes prices of petroleum across the country. In developed markets, it is normal for prices to be different at each filling station, and to be notably different in different areas to recognize transport costs and regional specification differences, where these are prescribed for good cause, such as air quality or altitude. Some countries with controlled or partially controlled prices have tried petroleum price equalization schemes as a means of helping the more remote areas and as part of a uniform pricing philosophy. These schemes work through setting a levy on sales throughout the country, with this levy going into a fund. The fund compensates for transport costs. Generally these are rife with fraud as the transporter claims for long distance delivery by road and, in reality, delivers only a few kilometers away, and the equalization funds are part of a "nanny state," anti-market attitude that is pervasive in many countries. Nigeria has also used this fund in the past to prop up the federal budget.

4.26 Nigeria has a pipeline system and can use this to create a more equal pricing regime. Best practice is to differentiate pipeline prices by distance; however, the existence of a developed, over-capacity pipeline system, as in Nigeria, permits (if this is required politically) price equalization throughout the pipeline system, as any reasonable tariff will exceed cash costs wherever in the system the product is delivered. Bulk transport prices would then differ only according to the transportation costs from the depots on the pipeline through to the filling station or major customer.

Potential Regional Benefits of the Existing Petroleum Transport Infrastructure

4.27 The product pipeline system has been extended close to Nigeria's borders in a number of places. This is particularly noteworthy because product shortages seem to hit these areas most. The location of the pipelines and storage depots makes it possible for some traders to buy petroleum products at low prices and take the product across the border, thus allowing the benefit of Nigeria's petroleum product subsidies to be shared by neighboring countries and the illegal trader, while Nigeria's border regions suffer from product shortages. The amount of subsidy exported to neighboring countries, in dollar terms at year 2000 prices, is most likely above US$20 million per year. A way to minimize illegal exports is to introduce a mechanism to compare product movement and storage inventories with retail revenues in specific areas, as well as to exercise tighter controls on the border.

4.28 The prices of petroleum products for Nigeria's neighbors, in particular, for landlocked Niger and Chad, as well as for the northwestern part of Cameroon, are among the highest in the SSA region (see Table 1). The existing pipelines which supply petroleum products to areas (for example, Yola, Maiduguri, Gusau) nearer to the borders with Niger, Chad, and Cameroon are underutilized due to the small demand in these areas. The pipelines could be extended beyond the borders and supply the neighboring countries with products which would otherwise be transported by uneconomical road tankers.

4.29 The increased supply of petroleum products to Niger, Chad, and Cameroon would have the positive side effect of raising the utilization and economic efficiency of the smaller branch lines that supply the border regions of Nigeria. Furthermore, pipeline transport enables controlled custody metering of petroleum products on the border, thus reducing the extent of illegal trade of petroleum products between Nigeria and its landlocked neighbors.

5

Next Steps

5.1 The countries of SSA need to undertake major policy changes to attract investors and financiers into the development of the badly needed petroleum transport infrastructure. Bilateral and multilateral agencies could play a role in reducing risks, provided the basic policy and institutional changes are implemented. To start, a separation of roles between the government authorities and the commercial operation needs to be decided.

5.2 Along with the policy changes, further studies are important to set priorities. These are studies to be based on extensive in-country research. Government consent is essential to explore new projects. This is the case of the "Petroleum Products Transportation Corridor from Djibouti to Addis Ababa" for which the involved governments have not been consulted so far.

Recommendation 1: Southern Africa Regional Petroleum Distribution System, Originating in Angola

5.3 In view of the positive preliminary economic evaluation for a Southern Africa-Regional Petroleum Distribution System, originating in Angola, it is warranted to initiate further investigations concerning a pre-investment feasibility study. The complexity of the study would require that the work should be split into economic and technical parts.

Recommendation 2: Assessment of Nigeria's Downstream Operations, Product Pricing, and Markets

5.4 Further to the results of Case Study Two, a thorough and up-to-date assessment of Nigeria's downstream operations, petroleum products pricing mechanism, and markets in neighboring countries is recommended. The main objectives of the proposed review of the downstream sector is to assess the products, market, pricing, and regulatory framework and the petroleum product pipeline systems, including an evaluation of the economic viability of several possible configurations for a regional product transportation and storage system

Recommendation 3: Petroleum Products Transportation Corridor from Djibouti to Addis Ababa

5.5 With the creation of an independent Eritrea, Ethiopia has become landlocked, and depends on imports to meet its growing demand for petroleum, estimated at 800,000 tons per year. Currently, the bulk of products is moved by road tankers, which cause considerable damage to the existing road infrastructure. With a capacity approaching 1.0 million tons per year, the economic viability of the pipeline vis-à-vis road or rail transport should be analyzed. A pre-feasibility study, including a site survey, is suggested to verify the economic viability of the proposed line. Djibouti has a deep water harbor to unload product tankers of an average 35,000 ton capacity. The proposed project will include sufficient storage tanks and related facilities for an unloading terminal in Djibouti. At the receiving points in Addis Ababa and other tap-off points, oil marketing companies will enhance their existing storage and related facilities and build new ones where there are no current facilities. The pipeline could be owned and operated by the private sector as a "common carrier" with equal access to all oil marketing companies.