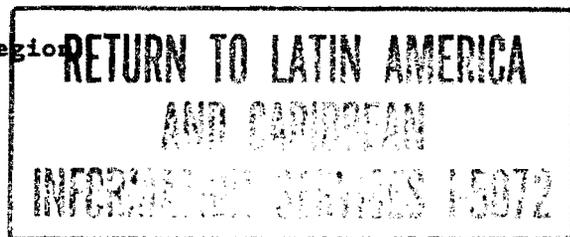


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**\* WORLD BANK ROLE IN PETROLEUM RESOURCES DEVELOPMENT:  
THE CASE OF HEAVY OIL DEVELOPMENT**

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**INTRODUCTION**

An adequate supply of reliable and low cost energy is essential for economic growth. In almost all developing countries the state plays a predominant role in the Energy Sector. In the oil producing developing countries, a large national oil company (NOC) generally dominates the oil sector and, with the exception of a few countries, there is also a large presence of a private sector. In oil importing developing countries, a dominant role is generally played by the State in the import of petroleum products. With few exceptions, there is also a preponderant presence of the State in the generation and distribution of electricity. As a result, these countries have mainly relied on public financial resources in the past to develop oil resources, import petroleum products and expand hydroelectric resources to meet their domestic and industrial energy needs. These expenditures, along with non rational pricing and employment policies, have strained public sector financial resources, aggravated budget deficits and increased their external debt burden.

Given the economic difficulties facing most developing countries and the looming scarcity of foreign exchange in energy projects, many countries are undergoing a restructuring of their economy to promote productive efficiency, exports and foreign investment. They are carefully examining the manner in which energy projects are selected. Alternative energy options are being examined taking into account their effects on the economy and their relative priority in public sector budget. Consequently, alternative energy sources are being studied such as heavy oil, natural gas and coal, as well as mechanisms by which the government investment burden may be decreased while fiscal resources are improved.

While facing great economic difficulties with adjustment policies, developing countries realize, however, that there are special issues constraining the development of energy resources which they have to address on their own. As regards heavy oil, the most important issues generally concern the following:

(1) energy policy may not differentiate between heavy and conventional oils in the promotion of heavy oil development through legal and contractual arrangements with the private sector. This differentiation may be needed to target private sector interest to heavy oil development because the National Oil Company (NOC) may be financially constrained, the NOC may prefer to allocate its

resources to high return conventional oil projects, the private companies may have better know-how, etc.

(ii) pricing policies of petroleum products and electricity may inhibit interfuel substitution and, in particular, the use of large quantities of fuel oil partly derived from heavy oil in power generation;

(iii) NOC may lack the necessary autonomy to achieve efficiency and a strong financial position due to Government interference in pricing, employment and procurement decisions which should be based on commercial criteria, along with inadequate subsidization and taxation policies; and

(iv) a clear policy on energy and, in particular, oil interregional trade may be needed, as a catalyst for resource development to address the oil needs of neighboring countries for example.

These issues are highlighted at this juncture to point out that heavy oil development is not only constrained by economic and technical considerations which are the major topics in this forum, but by other legal, regulatory, institutional and policy factors. This paper will address the following:

- o the economic role of petroleum ;
- o the objectives and criteria for bank petroleum lending;
- o the Tsimiroro Heavy Oil Exploration Project financed by the World Bank.

#### IMPORTANCE OF PETROLEUM CONSUMPTION IN THE ENERGY BALANCE

Oil will remain an important component in the energy balance to support economic growth at least during the next two decades, especially in the transport sector. Estimates of world oil consumption by the year 2000 vary according to assumptions on prices and economic growth rates for the industrialized countries, the newly opened centrally planned countries and the developing countries. The World Bank, 1988 estimates consumption at about 70 million barrels per day (MBD) in the year 2000 (57 MBD in 1985) with the developing countries share at about 33%, up from 27% in 1985, and the industrialized countries share at 51% , down from 55% in 1985, the difference being the consumption by the newly opened centrally planned economies.

The importance of the non-OECD in the world energy balance (IEA, 1989), is illustrated by the fact that its share of world primary energy requirements has grown from 37% in 1971 to a little over 48% in 1987. While coal accounted for 44% of non-OECD energy requirements in 1971 by 1987 this has fallen to 35%. On the other hand, dependence on oil peaked in 1980 at 41% declining to 35% in 1987. Natural gas has been the fuel to benefit from these developments mainly at the expense of coal . Natural gas accounted for 22% of non-OECD energy requirements in 1987. While the developing countries exported over three times as much oil as they consumed in 1971, by 1980 they exported only twice as they consumed.

This growth in oil consumption by developing countries has been uneven among different regions. Five countries in Africa (Algeria, Egypt, Libya,

Nigeria and South Africa) account for more than 75% of total oil demand in Africa. In Latin America four countries (Argentina, Brazil, Mexico and Venezuela) account for about 80% of total demand. In Asia, India, Indonesia, Singapore, South Korea and Taiwan account for just over 70 % of oil consumption. Finally, in the Middle East, Iran, Iraq and Saudi Arabia have a combined oil demand of about 70% of the region's consumption. It is expected that these developing countries will remain the major oil consumers in the future.

Now I would like to examine the impact of the petroleum sector on several key economic parameters such as labor productivity, balance of payments, public investments and fiscal deficit.

#### LABOR PRODUCTIVITY AND PETROLEUM PRICES

The economic impact of movements in petroleum prices illustrate the importance of oil, in terms of changing the incentives to employ energy resources and thus modifying the optimal method of production (Tatom, 1988). An increase in oil prices signals the need to minimize employment of energy-using capital and energy-intensive technologies and divert labor resources to less energy intensive uses. As a result, the existing capital and labor resources cannot sustain the initial rates of output. Tatom has shown the significant impact of oil price increases on the growth rates of output per worker in the seven countries comprising the OECD data set during periods of oil price increases.

#### BALANCE OF TRADE IMPACT OF OIL PRICES

Table 1 illustrates the magnitude of fuels imports in relation to exports of goods and services for some importing countries assuming an oil price of US\$25/bbl and 1988 data. Given the significant share of oil imports on the resources available to the national economies, an increase in the international price erodes the economic capacity of the oil importing country to use its resources for growth and social projects.

Table 1  
BALANCE OF PAYMENTS IMPACT OF OIL IMPORTS

<u>Region/Country</u>	<u>Net Oil Imports as % of GNP</u>	<u>Net Oil Imports as % of Exports of Goods &amp; Services</u>
<u>America</u>		
United States	1.23	11.34
Brazil	1.33	12.49
Honduras	5.10	20.33
Jamaica	9.13	14.91
<u>Europe</u>		
France	1.56	5.96
Germany	1.60	4.89
Italy	1.40	6.74
Spain	2.23	11.29
<u>Africa</u>		
Ivory Coast	4.45	11.43
Kenya	5.40	23.89
Mali	6.73	38.87
Tanzania	9.91	58.70
<u>Asia</u>		
India	1.05	14.81
Japan	2.20	16.92
Bangladesh	2.38	29.73
Philippines	4.30	15.74

Source: World Bank

#### OIL SECTOR SHARE OF PUBLIC INVESTMENTS

Investments in energy developments constitute (OLADE, 1988), the largest share of public sector investments in developing countries (up to 50% in some countries). In oil producing countries, investments by the NOC may require up to one half of the investments in energy development. This has usually led to foreign borrowings to finance energy development with a consequent increase in the public debt. OLADE has estimated that up to 18% of the total debt of Latin American countries is due to borrowings to finance energy development, half of which is due to oil investments by public sector companies.

#### GOVERNMENT OIL RELATED FISCAL DEFICIT

In most developing countries, the policy of charging the consumers prices (Kosmo, 1989) for petroleum products below international prices, has not helped the Government fiscal deficit. The most important energy subsidies exist in the oil-exporting developing countries. Because these countries are subsidizing oil

consumption and not encouraging conservation, they are not only making the fiscal deficit worse, but they are also foregoing foreign exchange earnings and reducing oil resources for future exports. Several of today's oil exporting countries could become net oil importers if they do not take steps to reduce domestic consumption through appropriate pricing and conservation policies. Moreover, these subsidies exacerbate the debt problems and foreign exchange shortages faced by many oil-exporting nations since excessive domestic consumption reduces exportable surpluses. Energy subsidies, on average, equaled one-third of oil exports revenues in the countries that were considered in the study (Kosmo, 1989).

#### WORLD BANK LENDING GUIDELINES IN THE PETROLEUM SECTOR

The World Bank is the single most important official source of external capital for energy development in the developing countries. Bank annual energy lending (including credits from the International Development Association - IDA) has tripled from US\$1 billion in fiscal year 1977 to over US\$3 billion in FY 87. The World Bank has lent to 118 projects in petroleum for a total amount of US\$5.9 Billion during the period 1972-1988 in developing member countries.

The objectives of the Bank petroleum lending are to help borrowers:

- o formulate a strategy and sectoral policies for the economic development of energy resources and their efficient use, with a particular definition of the respective roles and contribution of the NOC's and the private sector;
- o help with financing needs by mobilizing risk capital and commercial debt financing, and
- o help with the implementation of projects.

The general criteria for the Bank petroleum lending takes into account: (i) the country's petroleum sector policies and investment strategies, in terms of the role of the NOC's and private sector companies, the level and priority of investments in the sector, and petroleum products pricing policies, and (ii) institutional building in terms of the definition of the respective role of the Government and the NOC's in terms of their policy making and regulatory roles on the one hand and the commercial role on the other. The Bank is required to explore fully all prospects for financing such that Bank financing does not replace or displace other sources of finance. An agreement is reached between the Bank and the Government on priorities of the petroleum sector strategy before lending is approved for the sector. The following summarizes the Bank Petroleum Lending activities in the past.

### EXPLORATION PROMOTION

Bank activities in exploration promotion have included financing of:

- o studies covering the petroleum legislation and contractual framework to improve the competitiveness of prospective areas being offered to the private sector;
- o acquisition of geological, geophysical and other technical data to enhance the technical/economic attractiveness of prospective petroleum resources of the country;
- o preparation of promotional packages (including legislation, contract and technical data) and contact of oil companies to attract their investments; and
- o assistance by expert consultants to the government in the negotiations with oil companies, training of national staff and the set up of a contract monitoring system.

As of end-1989, Bank/IDA lending for petroleum exploration promotion totalled about US\$150 million for 29 operations throughout the world.

### PETROLEUM RESERVES DEVELOPMENT

Generally, the Bank will only finance petroleum reserves development that are carried out as a joint venture operation between the State or NOC and the private sector (Colombia Cano Limon and Ivory Coast Espoir for example). The Bank may consider lending for a project to be implemented by the NOC alone provided that:

- o the country has appropriate policies in the sector, including attracting the private sector or;
- o the Bank's involvement will result in significant improvements in sector policies.

In both cases efforts have to be made by the borrowing country to maximize other sources of financing.

According to the guidelines, Bank will finance projects implemented by NOC's alone only for:

- o natural gas field development,
- o rehabilitation/secondary recovery in producing fields,
- o early production facilities to test the field commerciality, and
- o pilot development, such as heavy oil demonstration projects.

## THE TSIMIRORO HEAVY OIL EXPLORATION PROJECT

### Project and risk

Before requesting the World Bank to help finance this project, the Madagascar Government agency (OMNIS) in charge of this project attempted to attract oil companies to exploit jointly the deposit with the Government. To that effect, OMNIS sent bidding documents to 89 international oil companies. The response to this call for bids was negative. The reason most frequently cited by the international oil companies was that the amount of pertinent data provided was inadequate to enable them to reach a reasonable decision.

In 1982 IDA made a US\$11.5 million equivalent credit to Madagascar to make it available to OMNIS as a grant to support the government efforts to evaluate the country's hydrocarbon potential with the objective of achieving domestic oil production in the future.

The main project components were the exploration of the Tsimiroro heavy oil deposit through a 10-well exploratory drilling program to determine the characteristics of the deposit, the engineering study of a pilot plant at Tsimiroro for testing production of the heavy oil under enhanced recovery techniques, such as steam flooding, the feasibility of upgrading the heavy oil recovered from Tsimiroro and the training abroad of about 12 professionals.

### BACKGROUND ON THE TSIMIRORO HEAVY OIL DEPOSIT

Located 270 km WNW of Antananarivo and 100 km East of Maintiano, the port on the West coast, the large Tsimiroro heavy oil deposit has been known since the early 1900's when several oil companies have drilled in the area, the last one being Chevron in the early 70's. Although valuable stratigraphic and petrographic data were obtained and a number of heavy oil impregnations were found as a result of these efforts, insufficient coring and testing were undertaken to confirm with any certainty the deposit's potential to produce hydrocarbons in sufficient quantity to justify development.

### GEOLOGY OF THE TSIMIRORO AREA

The rocks of the Tsimiroro area are made up of detrital formations of the Karoo system, a series of sandstones, siltstones and shales of permo-carboniferous, triassic, and early jurassic age. This series is very widespread across Southern Africa and in Madagascar represents the oldest sedimentary formations, lying on the crystalline and metamorphic basement. Its total thickness reaches 6,000 to 8,000 m, but in Tsimiroro area of interest its thickness ranges from about 1,200 to 2,500 m. The formations dip westward and thick sections of younger sediments overlie the karoo between Tsimiroro and the Mozambique channel.

The oil shows of particular interest for possible production are those of the Amboloando sand of the Isalo II formation of the Karoo system. The top of this sand in the Tsimiroro area lies at a depth ranging from about 75 to 300 m

below the surface. The sands are fine to medium grained, well sorted, with high Mica content and Kaolin or calcareous cement. The sands are in part lenticular, with variegated shale layers from a few centimeters to a few meters thick. The sands show cross-bedding characteristic of fluvial deposits, likely braided streams in a widespread delta plain.

The formation thins from NW to SE, showing a probable source of sediments to the NW. Near the North end of Tsimiroro, one of the Chevron wells had nearly 140 m of the Amboloando sandstone formation, whereas wells to the south had only about 75 m. These are gross thicknesses; the net sand thickness with oil is probably less than half. Effective porosity is about 20 percent but often less because of Kaolin cement. Permeability is low, about 250 millidarcys, a figure which is quite satisfactory for light oil production but is too low for heavy oil to flow out freely.

#### FEASIBILITY OF HEAVY OIL PRODUCTION

Consultants hired under the credit undertook a preliminary analysis of the economics of heavy oil production in Madagascar by adapting a study of a similar oil project in Alberta, Canada. The analysis assumed: (a) a drilling program of 156 wells and construction of central and satellite support and oil-gathering facilities; (b) actual field production of 7,500 BD, which after steam generation and utility demand would yield 5,000 BD of crude for ultimate sale; (c) a 25 year project life with construction and drilling ; (d) investment in full upgrading facilities; and (e) construction of a pipeline to Madagascar's West Coast. The consultants assumed the level of reserves, oil quality and production potential based on analysis of existing data and compared the economics with that based on the characteristics of the Alberta deposit on the basis of mid-1981 constant US dollars as follows:

Table 2

Heavy Oil Mini-Project In Situ Operations  
Comparative Factors

	<u>Alberta</u>	<u>Tsimiroro*</u>
In-place resource, billion m3	2	0.77
Depth below surface, m	600	300
Gravity, Degree API	13 to 18	14
Viscosity, mpa-s	500 to 50,000	5,000
Pay thickness, m	2 to 8	20
In-place reserves/well, (1,000 m3)	40 to 80	120
Well producing life, years	10	8
Initial maximum well rate (thermal recovery), m3/d	8 to 10	20
Recoverable reserves per well, (1,000 m3)	20 to 40	60
Production module:		
(a) no. Of wells in mini-project field module	50 to 100	156
(b) mini-project surface facility sustained design rate m3/d	500 to 1,000	800
(c) initial capital, million (US\$1981)	48	57
(d) unit capital investment, (1,000 US\$/m3/d)	80	71
(e) annual operating and replacement well costs, (million US\$1981)	13	15
(f) annual production, (1,000 m3)	300	290
(g) annual unit operating and well replacement costs, US\$/m3	42	53
(h) transportation & upgrading cost, US\$/m3	60	39
(i) manpower number	50 to 100	75

\* Cost figures based on assumption that construction would take place in Alberta.

A sensitivity analysis was run escalating capital costs and operating costs and on the basis of an 1981 oil price of US\$31/bbl escalated 2-2.5 percent annual real growth rate . The pessimistic case assuming 2.5 times capital cost escalation and a 2 times operating cost escalation gave a discounted cash flow rate of return of 12%. The rate of return declined to 1 percent when oil price were kept constant at US\$31 /bbl. The analysis, though hypothetical at the early stage of the project, indicated that if the production potential of the Tsimiroro deposit under steam recovery methods would be established, then the outlook was reasonably favorable that commercial production would be economically viable.

This feasibility study results led the consultants to recommend a supplementary exploratory program before deciding whether or not to commit to a pilot plant. This work program included the drilling of the 10 additional exploratory wells , laboratory work to better define the reservoir properties and fluids, conducting production testing and performing detailed studies based on the new data that will be obtained.

## THE PROJECT

OMNIS entrusted the implementation of the data acquisition to a consulting firm with the understanding that the latter would subcontract and coordinate the drilling activities, the laboratory studies, and the additional seismic surveys.

The implementation of the work program showed:

- o the scarcity and the complexity of the heavy oil accumulations as drilling of the wells progressed, and
- o the lower than expected cost of the drilling program due to easier drilling and decline in international drilling costs.

The drilling campaign started in July 1983. After 8 wells were drilled, the data confirmed that the reservoir had favorable characteristics for oil recovery by steam injection. In June 1984 four additional coreholes were drilled in an area where wells had encountered oil saturated sandstones. One of the wells was tested; after 91 hours of swabbing, 4.2 Barrels of oil and 437 Barrels of water were recovered. However additional drilling of 9 coreholes gave negative results.

In February 1987 the consulting firm recommended that no more exploratory drilling be carried out in the Tsimiroro area since out of 19 wells and coreholes only 4 encountered isolated heavy oil accumulations, and none had significant production upon testing. OMNIS is presently trying to attract oil companies in the exploitation of the small accumulations and in the exploration of certain areas recommended by the consulting firm.

## TRAINING

Technical training of OMNIS professionals was an important and successful component of the project. The training program financed by the World Bank was complemented by on-the-job training with oil companies exploring in Madagascar, consultants and contractors who were hired under the project. The training program included the following:

- o training programs for a total amount of more than US\$500,000. These programs were carefully designed and benefitted the whole OMNIS staff. OMNIS professionals attended courses in universities in different countries (U.S.A., Canada, France, Switzerland) for periods ranging from one to nine months, and

- o all of the contracts signed by OMNIS with consultants and contractors under the project included OMNIS training component. OMNIS professionals were thus involved in day-to-day tasks carried out by their counterparts in exploration, drilling, petrophysical analyses and reservoir studies.

While at the start of this project OMNIS staff were few and inexperienced, the present staff is, on the contrary, qualified, experienced and

capable of carrying out most of the exploration activities included in their work program.

### CONCLUSIONS

1. Oil, as an important source of energy, has major implications in terms of public sector investments and debt, fiscal deficit, balance of payments and economic growth and productivity.

2. Oil will continue to play an important role in the satisfaction of energy needs of the industrial countries but more so of the developing countries well into the 21st century. In light of the economic difficulties facing most developing countries, economic growth will require a low cost and reliable source of oil obtained with minimum public sector investments and priced internally at opportunity cost such that the government deficit and foreign exchange earnings are improved. This can be better achieved if the governments reviewed their pricing policies, eliminated barriers to entry by the private sector, ensured that public enterprises operated as efficient commercially oriented entities and promoted interregional trade in the petroleum sector. These conditions are necessary in particular for an efficient development of heavy oil resources.

3. Developing countries will analyze the potential contribution of all energy sources to satisfy economically their energy needs and taking into account their environmental impacts: enhanced oil recovery from conventional oil, heavy oil, natural gas and coal appear to have a large enough resource base to complement in the longer term lighter petroleum resources.

4. The World Bank has made a major contribution as the single most important source of financing of energy projects. In particular, the World Bank has financed more than 118 projects totalling US\$5.9 billion over the period 1972-1988 in the petroleum sector. The bank has had considerable experience in energy policy discussions with most of its borrowing member countries leading to important agreement on objectives and strategy in the sector, as a result of which several projects in oil development have been implemented in many countries. As a last resort, the Bank could finance in particular pilot projects in heavy oil development to prove their technical and economic feasibility and promote their full industrial development by the private sector or through a joint venture between State or NOC and the private sector.

5. The Tsimiroro heavy oil pilot project was initiated in 1982 with an IDA grant when oil prices were high and after both oil companies and an independent consultant study had recommended that additional data gathering work be carried out before attempting a field pilot project.

6. Additional drilling of 19 shallow wells and coreholes allowed the full technical analysis (laboratory analysis of the rocks and fluids) of the field data, the testing of wells to check whether significant production could be obtained and the initiation of a new engineering analysis based on more reliable data. As a result of the new data and engineering study, the consultant recommended that a pilot project would not be warranted but that further

exploration and reserves evaluation should be pursued in certain areas. OMNIS is now trying to attract interest by companies.

7. The most important contribution of the heavy oil exploration project was the training of a large number of Madagascar professionals in all areas of oil exploration and reserves analysis as well as petroleum management in universities and on-the job training with consultants, contractors and oil companies operating in the country. There are now experienced and capable professionals in Madagascar who initiate and promote not only heavy oil prospective areas but also attract private sector investments in other prospective geological areas of the country. Exploration by many companies such as Shell and BHP of Australia is still ongoing in Madagascar and there exists a large potential for heavy oil both in certain unexplored areas of Tsimiroro and the yet undeveloped Bemolanga tar sands deposit.

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