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ENERGY PLANNING ASSISTANCE FOR THE MINISTRY OF ENERGY AND MINES GOVERNMENT OF MOROCCO

Progress Report
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TABLE OF CONTENTS

		PAGE
I.	Introduction	1
II.	Review of the Energy Sector	2
	A. Current Status	2
	B. Coal Options	4
	C. Gas Options	8
III.	Training Seminar	11
IV.	Data Base	18
	Appendix 1 - Updated Project Data Base	22

1. INTRODUCTION

This progress report is a summary of the progress made by Energy and Environmental Engineering, Inc. on the Energy Planning Assistance Project for Development Sciences, Inc. and the Ministry of Energy and Mines, Government of Morocco under U.S. AID Contract No.5728-600-3001-00. Beginning on November 1, 1982 and completed on November 30, 1983, this contract is based on the technical assistance work conducted over two years prior to November 1983. This report summarizes the work accomplished between December 1982 through November 1983. In the past year, accomplishments have been made in the following areas:

- Preparation of the Minister's presentation;
- Presentation of training seminars in project evaluation;
- Development of additional energy projects;
- Updating the data base; and
- Reviewing current Moroccan energy resources and programs.

Energy and Environmental Engineering, Inc.'s continuous involvement in the project has been useful to the overall success of the energy planning assistance program. During the course of this subcontract, Mr. Samer Faraj, Project Manager for E^3I, visited Morocco twice. The first visit took place in March-April of 1983 and was followed by another visit in July of the same year. Work on the update of the ENVEST energy projects' data base has continued throughout the year. Revisions of older projects have been based on better definition of project parameters, changes in Moroccan data, and updated engineering estimates. Additional projects were also developed and added to the inventory. The majority were related to gas field development, transport, and utilization.

The training seminar was designed to present modern project evaluation techniques and to form a qualified staff who would be responsible for the collection and evaluation of the necessary data for each parastatal within the planning model.

The first part of this project presents a review of the energy sector; it includes a discussion of the current situation and a review of the various energy options under implementation, including coal and gas. The next section details findings of the staffs of the various energy parastatal organizations who participated in the training seminar conducted in April. The last section presents a discussion of the status of the data base and the format change inplemented in response to earlier recommendations. Finally, the appendix provides a detailed listing of the 51 projects currently in the ENVEST inventory.

II. REVIEW OF THE ENERGY SECTOR

A. Current Situation

The world economic crisis and the severe droughts of the last three years have had a serious impact on the Moroccan economy. In 1980, the Gross Domestic Product (GDP) grew at 4.0 percent per year in real terms. The following year, droughts and a depressed phosphate market caused a severe economic crisis which led to a GDP drop of 1.3 percent. The economy rebounded in 1982 due to adequate rainfall which more than doubled the grain crop. Overall, the GDP rose by 6.8 percent. This year the economic crisis has deepened and no significant growth in GDP is expected.

Since 1980, Morocco has fallen victim to the world-wide recession which has adversely affected most developing countries. The Moroccan 1981-1985 five-year plan projected a real annual growth rate of 6.5 percent. At this point, it does not seem possible that Morocco will resume such a high rate of growth without a sharp recovery of the world economy of which Morocco is an integral part.

The energy sector was one of the main growth areas in the five-year plan. The economic crisis, coupled with the continuous price rise of hydrocarbon products and electricity, has slowed the rate of growth of energy demand. However, the greatest impact of the economic situation has been felt in the unavailability of financial resources to undertake the energy resource development plans needed to meet the country's energy needs.

For instance, the hydro program is a victim of budgetary constraints and rising capital cost estimates. The program originally planned to build a total of 6 dams during the 1981-1985 period. Today, its scope has been reduced to a single multi-purpose project to be partially funded by the World Bank.

The shale retorting program has been scaled down. The relative drop in world oil prices and the lack of strong interest by technology-owning western firms has led to the postponement of a large scale continuous retorting shale project. The T3 program funded under a World Bank technical assistance loan is the only major development work currently being undertaken.

Because of the combination of a lack of funds, environmental concerns, water supply constraints, and high cost estimates, the proposed 200-250 MW electricity generating shale burning unit has been postponed. A coal burning power plant of approximately the same rating has been proposed. It will be located near the coal importing port.

Energy demand growth has slowed down over the last three years compared to the situation prevailing in the 1970's. The government has tried to influence demand through the pricing and taxing mechanism, but results have been relatively limited. In 1982, electricity production grew by 6.8 percent and petroleum product consumption increased by 5.1 percent. The growth of energy consumption remains relatively high in spite of the dras

tic price increases undertaken by the government. Table 1 lists the increase in prices for selected energy products over the last seven years. Moroccan liquid fuel and electricity prices, which were lower than the world market price, have risen much faster than oil prices and today serve as an indirect tax to finance the budget.

Table 1
Energy Price Increases for Typical Fuels

	1976	1983	% Change
Electricty (DH/kwh)	.15	.55	367
Fuel Oil (DH/Tomme)	169	1800	1065
Gasoline (DH/liter)	1.80	4.70	261

Source: Economist Inteligence Unit, Quarterly Review of Morocco, 3rd quarter, 1983.

The electricity generation system has been directly affected by adverse circumstances. Hydraulic installation accounts for approximately one-third of its electricity production. The droughts which have plagued the country since 1980 have directly affected the output of hydropower electricity. Brown-outs and reduction in service steps were put into effect in the summer of 1983. The coming on line of slices 3 and 4 of the Mohammedia power plant will help alleviate the shortage. However, this addition will have a negative impact on the balance of payment situation for it will initially run on fuel oil rather than on coal as planned. Slices 3 and 4 of Mohammedia are designed to burn cheaper imported coal; however the change in site for the coal port from Mohammedia to Jorf el Asfar, coupled with the delay in the port's realization, will result in boilers firing fuel oil until the ports are completed.

The nuclear power program has also been altered. To meet the projected demand, initial plans included the construction of a 600 MW nuclear plant by 1994 which would be followed by a new power plant every two years. The reduced energy demand growth rate and a reassessment of the economic capability of Morocco have led to the conclusion that such a program is unwarranted. Currently the goal is to have two units operating before the year 2000 with the first unit going on line in 1997.

The critical development in the energy sector are those affecting the coal usage sector and the gas being extracted at Meskala and at Toukimt. The next two sections provide an in-depth analysis.

B. Coal Options

1. Introduction

The future of coal in Morocco is dependent on the development of the national coal mine at Jerrada and the coal import policy. According to some estimates, the national production of coal could reach 2 million tonnes by the early nineties while coal imports could exceed 3.2 million tonnes in 1990. Clearly, the coal option plays a major role in meeting the energy needs of Morocco. Already, the transformation process is well underway with significant amounts of coal being imported to meet the needs of two cement plants and an electricity generating station.

In view of the importance which coal is acquiring in the energy sector, an analysis of the current role, future use, and potential difficulties of the coal option is needed. This section attempts to address these issues at a preliminary level; the development of one or several coal scenarios for the ENVEST model will require a more detailed level of analysis, especially at the project level.

2. National Resources and Their Use

a. Current Status

For all practical purposes, the Moroccan coal reserves are concentrated in the Jerrada basin. The Jerrada mine has been in existence for decades and went through difficult times until 1972 when the ONE power plant became operational. Since then, the major part of Jerrada production has been consumed at this power plant. However, the mine's current level of production is insufficient to meet the requirements of the ONE power plant which is used as a baseload unit. Production at the mine over the last five years has fluctuated between 500 and 700 thousand tonnes per year. Based on the current breakdown in coal grades, the ONE plant needs a mine's total production of 1 million tonnes to run at full capacity. The mine's insufficient capacity of production leads to sub-optional utilization of electric capacity and in periods of hydro shortages, as in the summer of 1983, it is a binding constraint for the electricity generation systems of Morocco.

b. Expansion Plans

Faced with the requirements to meet the needs of the Jerrada power plant and in order to reduce national petroleum consumption, Charbonages du Maroc (CDM) has undertaken the 1981-1985 five-year plan horizon expansion project. The project aims at raising the mine's output from 700 thousand tonnes to one million tonnes a year. The initial completion date was 1985; currently, the target date is the end of 1986.

The project faces a number of difficulties and uncertainties. On one level, funding may be reduced which would reduce the pace of modernization and delay the project's completion. On another level, there is considerable uncertainty regarding the size, disposition, and extractability of the coal reserves. Current known reserves amount to 16 million tonnes. CDM assumes that they will be able to extract 80% of available reserves.

While the 80% assumption might be realistic for a typical deposit, it is likely to be too high for a deposit as difficult to extract as Jerrada is. More importantly, CDM made questionable another assumption regarding probable reserves currently estimated at 20 million tonnes. Not only does CDM assume their existence and exploitability, but it also projects a similar figure of 80% for extractibility. The result is a project with a 27 year life. It is our suspicion that the assumptions underlying the calculation of reserve size are too optimistic for the following reasons: the Jerrada coal deposits have been only superficially explored and much of the structure and extension of the deposit remain unknown. The project's effective life may be 20 years or less. Finally, the annual cost projections are based on current average costs of production. Generally, resource extraction costs tend to rise as reserves are exhausted. If Jerrada is a typical coal deposit, then the projected annual cost will follow the rising marginal cost of production rather than stay in line with current average costs.

c. The Siege 6 Project

The Siege 6 extraction project is aimed at opening a new mine to the west of the current extraction zone. The coal deposits in that area are minimally explored and poorly mapped. The reserves are estimated at more then 40 million tonnes. However, none of these reserves are considered certain; hence, they fall in the probable reserve category. Obviously, no coal extraction project of the magnitude planned by CDM is to be undertaken without a major exploration and mapping effort. Beyond the uncertainty regarding the size of the reserves there are indications that the coal field is of marginal quality. Also of concern is CDM's optimistic extraction goal of 75% (which leads to a project life of 30 years.). Much uncertainty remains on all these dimensions even though CDM seems to be constantly optimistic about the project.

The economic data presented in the fiche project seems biased even at this preliminary level. One example is the capital investment needed for the mine's development. According to CDM, the marginal cost per tonne of capacity of opening a new mine is lower than the marginal cost of expanding the current Siege 5 mine. While this projection is possible, all the information available to the project staff seems to indicate the opposite.

Finally, a major question hangs over the potential market for the coal. CDM seems confident that they can sell whatever amount they can produce. However, by the late 1980's and early 1990's much of Jerrada's potential market will be consuming imported coal delivered at a price possibly lower than Jerrada production cost.

3. **Coal Imports**

a. Current Status

SOCOCHARBO began importing coal in significant quantities in 1982. Currently, the three users are:

1. ONE power plant at Roches Noires;
2. LAFARGE cement plant at Casablanca; and
3. CADEM cement plant in Meknes.

The Roches Noires Power Plant conversion started in September 1982. It covers the 2X30 MW fluidized bed combustor. The plant began operating at full capacity (600 tonnes coal/day) in June 1983. The coal is imported from England based on an 18 month contract of 200,000 tonnes. The price is firm at $42.50/tonne CIF Casablanca. The coal is a low-sulfur, low-ash anthracite with a low heating value of 6450 Kcal/kg.

The CADEM plant is currently in the process of converting from a wet process to a dry (or semi-dry) one. They had originally run on coal before switching to fuel oil during the cheap oil era. In August 1982 they did their first runs with Jerrada Anthracite and consumed 10,000 tonnes by the end of 1982. In 1983 they wanted to purchase more important quantities of Jerrada coal, but Jerrada was unable to meet their demand. CADEM then became interested in petroleum coke and has since operated with a mixture of coke and coal. The trials with petroleum coke were undertaken during the February-March period of 1983 and were successful. The final obstacle to handling solid fuel (crushing capacity) was removed in May 1983 with the purchase of a second-hand crusher.

In June 1983, LAFARGE started using coal as a fuel in two of its five burners. It signed an 18-month contract with SOCOCHARBO starting in June of the same year for the delivery of coal. CADEM also signed a contract over the same period. These contracts can be detailed as follows:

June-Dec. 1983	1984	
CADEM	15,000 T coal 30,000 T coke	30,000 T coal 60,000 T coke
LAFARGE	55,000 T coal	100,000-110,000 T coal

The petroleum coke has a calorific value of 7500-7600 KCal/Kg. It is imported on short term contracts at a price of $52.50/tonne from the U.S. The coal used in the cement sector is purchased from England at 37 pounds/tonne CIF ($56.5 at 1.53 pounds/US $). It has the following characteristics: 20-25% volatiles, 8-10% ash, 8-10% water, 1.5-2.5% sulfur, and 6400 Kcal/kg LHV.

The sugar refining sector is also a major coal user. SUNAB and SUNAG will consume 25 to 40 thousand tonnes of Jerrada anthacite mixed with 5 to 12 thousand tonnes of imported coal this year alone. There are also two to three brick makers which consume approximately 300 tonnes of coal per month.

b. Future Markets

The AGADIR cement plant has decided to go ahead with its conversion plans. Even though the harbor is a limiting constraint, they will import coal by small shipments through Agadir. Coal use in the amount of 45 thousand tonnes should start in 1984 and reach 1000 thousand tonnes by 1987-1988.

The CIOR cement plant is contemplating switching to Algerian gas. No further information is available regarding this very unique transformation.

LAFARGE 2 has started production but will burn fuel oil for the near-term. It is expected to shift to coal in the near future. Also, the Temara cement plant is waiting to see how everyone else fares before undertaking its own conversion.

ONE's power plant at Mohammedia (Units 3 and 4) should go on-line in 1984-1985. Their potential consumption exceeds 7000 thousand tonnes of coal per year. Another major coal consumer will be the two 300 MW thermal power plants needed by ONE to replace the shale thermal program. The plants should go on-line in 1990-91 and consume 1.5 million tonnes of coal. The location of the plants will be either Mohammedia or Jorf-el-Asfar.

c. Pricing of Imported Coal

The current price of imported coal for Roches Noires is 450DH/tonne CIF Casablanca. The price jumps to 765DH/tonne (all taxes included) when it departs from the harbor. Import duties represent 207DH/tonne, and 12.5DH/tonne must be added to the final cost as a transport cost to Roches Noires. While the new law reducing the import duties on coal is going into effect sometime this year, its impact will not be very significant; duties will go down between 42 and 52 DH.

When Jorf-el-Asfar becomes operational, 30 DH/tonne will be required to transport a tonne of coal from the port to Casablanca. For distant destinations ONCF charges 25 centimes the tonne-km.

4. Infrastructure and Transport Problems

The Jerrada expansion project (Siege 5) will not face any transport infrastructure difficulties for most of its output will be consumed on site. Potential distribution problems might arise when the Siege 6 project starts production. However, since the potential market has not yet been identified in detail, a discussion on transport infrastructure must wait for a detailed definition of the project.

Coal imports represent a major challenge in transport planning. Initial plans had Jorf-el-Asfar going into service in 1984 in time to supply the third and fourth units of Mohammedia. However, due to budget cuts and construction delays the port will not enter into service within the original time frame. Thus, ONE has decided to operate units 3 and 4 of Mohammedia using fuel oil.

The Casablanca port is currently able to receive boats of 20,000 tonnes of capacity. Dischargement is undertaken at the mineral export dock. Current import capacity is around 300,000 tonnes. SOCOCHARBO would like to take over the whole dock and improve the dischargement system. Capacity could then reach 500,000 thousand tonnes. Furthermore, SOCOCHARBO would like Jorf-el-Asfar to meet the ONE import requirements while Casablanca meets

the needs of the nearby cement plants. An advantage of such a set up would be a diversification in coal ports' capacity. The Ministry of Equipment, on the other hand, wants to concentrate all coal imports through Jorf-el-Asfar and to use rail to distribute it to the customers. In any case, the ability of ONCF rail lines to transport important qualities of coal by train from Jorf-el-Asfar is in question. This potential bottleneck has not yet received the attention it deserves.

5. The Future

Morocco seems well underway into the new coal age through the importation of coal. SOCOCHARBO presented the following import projections during a meeting with SOCOCHARBO in July 1983. Those numbers are based on the assumptions that Jorf-el-Asfar will come on line before 1987.

1987 Horizon	
Mohammedia (Tranches 3&4)	700,000 T
Roches Noires	150,000 T
Lafarge & CADEM	200,000 T
CIOR & Agadir	200,000 T
TOTAL	1.4 million tonnes
1990 Horizon	
2x300MW ONE plants	500,000 T
Other cement plants	300,000 T
SUB TOTAL	1.8 million
TOTAL	3.2 million tonnes

If we add these numbers to the CDM (optimistic) predictions, we arrive at a total of 5.2 million tonnes of coal consumed per year. If this timetable is met, then Morocco will have gone a long way in meeting its diverse energy source goals.

C. Gas Options

Two years ago, assessments regarding the size of the Meskala gas find began to consolidate around a preliminary estimate of 1000 billion cubic meters. Based on this Moroccan information and with confirmation from the World Bank, E^3I made a preliminary assessment regarding the potential use of the gas in the Moroccan economy. Scenarios for capacities of up to 11.5 million cubic meters per day and pipelines extending to Tangier were developed. However, the arrival of the Bechtel support team brought realism to the optimistic estimates. Current reserve estimates range between 1/10th and 1/100th the size of the original estimates.

The reduced reserve estimates created the need to update the gas transport and utilization projects in the data bank. A portion of E^3I's efforts focused on discussions with the Moroccan and Bechtel staff on the most likely gas utilization scenarios.

Currently, there are two main gas fields in Morocco. Both are in the Essaouira region, and approximately five kilometers separate the two fields of Meskala and Toukimt. The Moroccan government is presently undertaking

the development of both gas fields without major international private capital involvement. As the investment required for bringing on line the fields is substantial and because MEM's budget has no major allowances for gas field development, the strategy to be followed will be different from typical field development practices.

Generally, significant production does not start until the field is completely mapped and tested, and reliable estimates of its yield established. When this initial program is completed, plans are drawn regarding the optimal gas extraction rate from the field. Gas line sizing is then undertaken accordingly. The strategy required by the Moroccan situation differs from common field development practices. According to ONAREP, such a strategy needs to generate, as early as possible, an initial revenue stream to be used for the development of the gas fields. Because of the paucity of financial resources, ONAREP needs to commercialize some of the gas before the full recognition of the field is completed. Through commercialization, ONAREP can generate the funds necessary for the development of the find. This approach requires the planning and construction of facilities with large capacities and flexible designs. Such a development strategy carries with it some risk. The reserves may be too small to justify such an extensive capacity or they may be much larger, requiring the development of another network of gas plants and gas lines.

The new gas projects reflect such an emphasis. The Toukimt pipeline is designed for capacity of 250,000 m^3/day even though the ASMAR plant will initially use a 100,000 m^3/day. Preliminary estimates on reserve size at Toukimt indicate that ASMAR could only be supplied in gas (100,000 m^3/day) for ten to fifteen years. The oversizing was done for the case where reserve recognition will significantly increase gas reserves.

A similar approach is used to develop projects for the Meskala gas field. The pipe was sized at a hefty 20 inch diameter, but initially it was to be sent only through the phosphate region up to Bengueir. Later, based on reserves availability plans call for the pipe to be extended to the Casablanca-Mohammedia region. The design capacity at that point is less than 3 million m^3/day. However, it could be increased by the addition of extra pumping stations to above 4 million m^3/day.

A pipeline is also planned to transport the condensate from Meskala to the Samir refinery. It is sized to meet the condensate production associated with the full development of the gas field.

In addition to the gas plant and pipeline designs, a couple of energy conversion projects are included. Those projects which are currently assumed to have minimal capital costs are scheduled to go on line when the relevant gas distribution project is completed. All gas conversion projects at this point are switching from fuel oil to gas.

At this point in time, the debate over natural gas pricing is at a crucial stage and could be a major hurdle to the rapid development of gas usage. In 1979, ONAREP started negotiating with OCP (the state phosphate monopoly) regarding their usage of Toukimt gas at Youssoufia. Negotiations initially proceeded well and ONAREP designed and constructed a gas plant and a pipeline system which linked Toukimt to Youssoufia. Disagreements

over prices proved to be too great, however, and no agreement was made. OCP then preferred to continue burning fuel oil, and the gas line remains unused to this day.

ONAREP's current efforts to commercialize the Toukimt field have focused on the ASMAR cement plant near Marrakesh and on a gas turbine for ONE. Negotiations with ASMAR have stumbled over the question of price. The cement plant would like to receive gas at a price equivalent (on a BTU basis) to 75% of the price of fuel oil. While recognizing the need to give a discount to encourage conversion, ONAREP would like to get 85% to 90% equivalence in price.

ONE is interested in building a gas turbine near Toukimt with a power rating of 10 to 25 MW. Depending on the size of the reserves and the availability of the gas, ONE will decide on the appropriate size. However, ONE's starting position in the negotiations is that the gas price should be between 450 and 700 DH per tonne equivalent petroleum. Such a price is roughly equal to a third of the fuel oil equivalent price called for by ONAREP.

The most critical factor affecting the development of gas usage in Morocco is price. The most likely customers will initially be the state owned parastatals. Based on their nature as semi-independent units, these entities have a tendency to operate as self-interested actors trying to optimize their own organizational gains. At times, such a free market appoach in a fiscally and organizationally distorted setting can lead to suboptimal decisions from the national point of view. It is likely that close evaluation and supervision from the Ministry of Energy will be needed to set prices and develop gas use in a national perspective.

III. TRAINING PROGRAM

A. Objective

The objective of the Training Program was to teach modern project evaluation methods in conjunction with training of para-statal staff for the data needs of the ENVEST model. The aim was to form, in each organization, a number of qualified people who would be responsible for the collection and evaluation of the data necessary for the project files.

B. Organization of the Training Program

The training program followed the April 15th presentation. The program started Monday, April 18th and concluded on Thursday, April 21st.

Monday, April 18th (9:00-12:00)
This first session was dedicated to a general presentation of the model and a discussion of its structure and operation.
Monday, April 18th (3:00-6:00)
This session focused on the theory and methods of project evaluation. The program stressed the presentation and understanding of the project evaluation part (ENVEST I) of the energy planning model.
Tuesday, April 19th through Tuesday, April 21st
A total of six sessions (two per day and three hours in length) were given. These sessions covered the usage of ENVEST 1 for the improvement of the existing data bases and the incorporation of new projects in a format similar to current project files.

All the trainees attended the Monday, April 18th session. From Tuesday through Thursday, each session was attended by a specific parastatal. This schedule reduced the size of the work group which could focus on the evaluation of the projects specific to each parastatal.

This training structure suited the major aim of the training program which is the selection in each parastatal of one or several "correspondents" for the needs of the planning effort. These correspondents will be permanent contacts at the level of data and project information for the planning needs of the ministry.

C. Attendance

About 50 representatives of different parastatals and ministry groups attended. They represented the following organizations:

1. MEM-Direction de l'energie
2. CDER-Centre de Developement de l'Energie Renouvelable
3. ONAREP-Office National de Recherches Petroliere
4. CDM-Charbonage du Maroc
5. SOCOCHARBO
6. ONE-Office National d'Electricite
7. SCP-Societe Cherifienne du Petrole
8. SNPP-Societe Nationale des Products Petroliers
9. OCP-Office Cherifien des Phosphates

D. Summary of Sessions

1. Renewable-CDER and SOCOCHARBO (Solar)

The CDER staff present at the training session focused on the difficulty encountered by renewable energy advocates in generating projects of sufficient size to impact the planning process. Most current or planned renewable energy projects are small pilot units and as such are unable to stand up to the comparative economic assessment process in ENVEST. To answer those concerns the training sessions was divided in two parts: (1) a detailed presentation of the project file data needs; and (2) a discussion of ways and approaches to forecast market penetrations of new and renewable technologies.

The initial presentation reviewed a number of renewable energy projects already characterized by the USAID team. Sources of data, technical assumptions and costing methodologies were discussed. Sococharbo also contributed with a detailed exposition of their solar hot water collector manufacturing activities and a breakdown of their production cost. The second part of the seminar described ways through which the experience gained with demonstration systems could be used to generate larger scale renewable projects within a format compatable with ENVEST's detailed data base. The seminar concluded with an agreement on the following note: the month of May will be used to develop project data in a format useful for planning activities and in June the USAID team will return to review the data and incorporate it into the data base.

2. Gas-ONAREP

Because of the size and level of expertise of the ONAREP staff, the gas seminar was of a more technical nature. Initially, the discussion focused on the engineering of the projects developed by E^3I for use in the model. The results were compared with the latest information available to ONAREP staff. Much discussion was generated by the issue of gas pricing. The Cadem conversion was discussed in terms of where the price of gas might settle. ONAREP felt that gas prices should be on par with fuel oil prices per calorific unit. However, they understood the need to give a 10% to 15% discount to encourage users to take the risk and change fuel sources. ONAREP also gives high priority to the signing of its first customer for the Toukimt gas field. Negotiations are in their final stages with the ASMAR cement plant near Marakesh. The revenue from this venture is crucial to the rapid development of the main gas field at Meskala.

3. Coal-CDM & SOCOCHARBO

The coal seminar focused on projects in two areas: local exploration and production expansion projects and coal importation programs. The Jerrada coal mine is in the middle of a production expansion project that will bring its capacity to 1 million tons of coal per year. The current price charged by

CDM to industrial clients seems to be higher per unit of heating value than imported coal. The marginality of the Jerrada coal becomes even more apparent when the issue of coal import tariffs is brought up. In addition, CDM revenues do not balance its production costs.

A proposed change in import tarification is due to take effect this summer. In a step to equalize the duties on petroleum and coal products, a 10% supplemental import tariff is to be removed from the coal duty structure. Such a change will improve the competitiveness of imported coal against both Jerada coal and more important fuel oil. Further, it is an important signal to industry regarding government priorities in the energy field.

The coal option is very attractive to most cement plants which are situated near a port and capable of burning coal without much capital investment. Table 1 details the cost differential between coal and fuel oil for the LAFARGE plant in Casablanca.

TABLE I
Price Difference Between Coal and Fuel Oil (1983)

	Cost(CIF)	Cost Delivered at Factory ($/tonne)	Energy Content (10^6BTU/tonne)	Energy Cost ($/$10^6$BTU)
Coal	$57/tonne	78	25.8	3.0
Fuel Oil	$29/barrel[1]	218	45.3	4.8

1. Price of unrefined petroleum (Saudi Arabian light crude, FOB)

Faced with a 60% price advantage in favor of coal and spurred by the reduction in import tariff, more than half of the cement plants in Morocco are undergoing or planning on switching to coal.

The development of the Jorf-el-Asfar port is critical for the growth of coal imports. Current Moroccan ports are generally overcrowded and lack deep water reception docks and rapid unloading equipment.

The port of Jorf-el-Asfar is scheduled to go on line by 1985; it will be able to handle boats of up to 50,000 ton capacity. The initial user of the port will be the Mohammedia power

plant Units 3 and 4. Table 2 details the comparative advantage of burning coal versus fuel oil.

TABLE 2
Coal Comparison of Coal Versus Fuel Oil for Mohammedia Power Plant

	Cost(CIF)	Cost Delivered at Factory ($/tonne)	Energy Content (10^6BTU/tonne)	Energy Cost ($/$10^6$BTU)
Fuel Oil	$29/barrel	218	54.3	4.8
Coal	$47/tonne	76[1]	24.2	3.1

1. Includes:
   Dischargement: Cost at approximately 80 DH/Tonne
   Tariffs and tax: Cost at approximately 80 DH/Tonne
   Transport to Mohammedia: Cost at approximately 31 DH/Tonne

The cost advantage for ONE is about 52%. However, the complete financial analysis is less attractive due to the higher capital investment and operation costs associated with coal fired power plants.

4. Electric Sector-ONE

The seminar dealing with ONE and the electricity generation projects was the best attended. Practically all of ONE's equipment divison was present at the sessions to discuss our data base and present their concerns.

The main thrust of ONE's concerns was that projects should not be analyzed comparatively. Even the comparison of IRR's across projects was opposed on the basis that electricity generating projects, especially hydro, will be singled out as low return projects. ONE felt that the regulations and distortions present in the energy sector did not permit straightforward and unbiased economic evaluation.

The debate then shifted to specifics about each project. Hydro was the center of controversy because of the differing approaches used in project evaluations. ONE initially took the position that the dam cost should not be included in the evaluation because it was financed by the state and built mainly for irrigation purposes. The USAID team did not agree with the proposed evaluation scheme. The team presented economic cost/benefit allocation principles as the guiding rules in evaluating multidimension development projects.

In retrospect, it seemed that ONE preferred not to quantify benefits in order to avoid the distribution costs between users. The rationale was that it was a difficult task requiring a major study of each dam. It was finally agreed that even a simplistic allocation of benefits was an effective step towards cost benefit analysis. ONE will try, during the early part of the summer, to develop numbers regarding their share of the cost of the dam. While this step will reduce the attractiveness of the hydro investment, it is preferable to having the analysis based on the arbitrary allocation to electricity of 50% of the dam cost. Both E^3I and the World Bank team made that assumption when faced with ONE's initial position.

Beyond the methodological issue, the question of the cost estimates needs to be clarified. So far the Moroccans have decided to go ahead with the Ommougez hydro project (it has been delayed by one year). The current cost estimates are several times higher than the initial estimates developed in 1982. Table 3 details the differences.

TABLE 3
Cost Estimates for the Ommougez Dam

Year	Power Capacity (MW)	Cost of Generating Plant (10^6DH)	Cost of Dam (10^6DH)
1982	67	365	520
1983	67	510	1500

It is not clear if such a high cost inflation is applicable to all the hydro projects. In any case, it warrants a review of the economic attractiveness of the projects. This is not to claim that the hydro projects should be cancelled. The projects have multiple objectives such as irrigation, flood control, rural development, employment and electricity generation. As such, any of these objectives and the fact that they are a national energy source could override narrow economic criteria as the basis for decision. However, it is crucial to have a clear understanding of the economic consequences of the investment decision.

The issue of usage of gas for electricity generation was also discussed. ONE has no plans to build gas-fired power plants. Their strategy is to initially switch Mohammedia I and II from fuel oil to gas and if the gas reserves are larger than anticipated, to burn gas in Mohammedia III and IV.

Finally, because of the lowered growth rate in electricity demand, the shale electric program has been put on the back burner. Limited water resources at Timahdit and environmental concerns have also played a key role in the decision. ONE is considering building a number of 250 MW imported coal fired power plants in order to make the transition to nuclear power. The nuclear program has been reduced and delayed. Rather than having four nuclear power plants on line by the year 2000, the current plans call for two power plants to go on line in 1997 and 1999, respectively.

5. **Petroleum Sector**-SCP, MEM and SNPP.
This seminar focused on the problems of the petroleum sector and on the potential use of the model for planning purposes. The outlook for petroleum products demand has radically changed since the late seventies. The demand growth rate which used to be around 8% to 9% a year has dropped and has stabilized around 4% annual growth. The reduction in demand growth rate is due to two main factors: the current economic crisis which is touching Morocco and the successive rise in internal petroleum product prices.

Faced with a low growth rate in demand, the refining sector is suffering from under-utilization of capacity. If the situation remains the same, this sector does not foresee the need for a new refinery before the end of the century. Further, the two Moroccan refineries are experiencing an inbalance in product mix. This is due to the way the refineries operate. Production is optimized to meet the internal consumption in fuel oil and gas oil. An imbalance necessarily exist for the other products. Generally, there is a surplus of gasoline and a deficit in butane.

The addition to the production stream of condensate from the gas fields was not seen as presenting any technical problem. It would, however, increase the production of light products. If gas is substituted for fuel oil on a major scale in the economy, the refineries will then produce an excess of fuel oil.

6. **Uranium Extraction from Phosphate**-OCP & MEM
This seminar discussed the potential for gas use by OCP and the extraction of uranium from phosphoric acid. OCP does not yet have specific plans for large scale gas use. They already burn a limited amount of gas at Khouribga which is supplied from a small SCP field. They generally agreed with our projection that OCP could consume approximately 350-400 thousand m^3/day of natural gas as a replacement for current fuel oil consumption.

Uranium extraction from phosphoric acid is the scope of a project due to start this year. The project consist of a liquid processing unit which separates the uranium mineral from the phosphoric acid production stream. The potential capacity of

production is high (approximately 550 tonne/year for the Safi installations and 450 tonne/year of uranium for the Jorf-el-Asfar site). For comparison purposes, a 600 MW nuclear plant consumes between 50 and 100 tonnes of uranium per year. The studies undertaken by the Moroccans predict production costs to be within the range of 20 to 35 dollars/lb. The current world market price of uranium is $20/lb, three years ago it used to be at $40/lb.

In view of the several limiting economic and technical factors, the Moroccans are building their uranium extraction capacity slowly; the first project, due to go on line in 1985, will have a capacity of only 150 tonnes/year.

IV. THE ENVEST DATA BASE

A. Status of the Data Base

The ENVEST data base contains a total of 51 projects. 50 of these projects are formatted in "fiche projets" and are installed in the computer data base. The last project is the uranium extraction unit and is not yet inputted in the model data base.

The data base consists of a whole range of electricity production, fuel switching, pilot unit, resource development, energy extraction and energy distribution projects. Because of the different project categories, the files need to contain fairly different types of information. On another level project data varies in terms of accuracy and reliability. Some projects, often the ones under construction, are described accurately while others, often representing potential development options, have only preliminary data.

In short the data base contains information derived from:

a. back of the envelope estimates,
b. prefeasiblity studies,
c. feasibility studies,
d. engineering studies, and
e. construction bids.

Such a disparity in lével of analysis is compounded by the fact that there are mainly two sources of project information: Moroccan data and U.S. team estimates. Finally, the data base was developed over more than three years by different groups of people. The process of project generation is sometimes not well documented making it difficult to replicate the thought process and identify key assumptions regarding certain projects.

B. The New Format

The new format currently being implemented in the model is an improvement over the simple format used initially. Specifically, it divides capital investments into labor, imported materials, and local materials. Operating costs are similarly divided. Such an approach obviously leads itself to shadow pricing, something which we were unable to do under the old format. Obviously, the ability to divide the cashflow into foreign currencies and various labor categories brings us closer to the goal of evaluating projects economically rather than from a narrow financial perspective.

The improved analysis capability comes at a price: an increase in the number of variables and the division of a number of old variables into several components. The increase in the required level of project information detail places a heavy burden on the project analyst. His task is greatly increased, but more important, he is asked to generate information which is generally only derived at the level of detailed studies. This is the challenge facing the project analyst--to generate detailed project information at the level of a preliminary investigation. The only feasi

ble approach then becomes the use of historical information, comparative evaluation, and especially the use of engineering judgement.

C. The Variables Change: Initial Comment

1. Capital Cost

The investment cost associated with each project used to be considered as a single variable. In the case of Morocco where foreign exchange resources are limited and the Dirham overvalued, such a simplification negatively affects projects with large local components. The proposed approach divides the investment into local and foreign currency components thus permitting the use of the foreign exchange shadow price.

Construction, and more specifically construction labor, is a gray area. The new approach does not develop construction labor as a separate category. It is included under either foreign or domestic investments. The variable INVEMP can be used to keep a record of construction labor divided into various categories. While generally of a limited importance with regard to its impact on the overall attractiveness of the project, it can play a critical role in identifying projects with large labor components. This is especially useful in situations where the employment objective needs to be maximized.

Practically, even the simple division of capital cost into domestic and foreign components can be difficult. The successful modelization of the construction process depends on two issues. The first is the capability of the local Morocco firms and workers to undertake some of the project work, the second issue is whether the local capabilities will in fact be used by the main contractor. While both these issues need to be studied as soon as posible, it is possible to generate single percentage breakdowns based on the type of technology and project experience in similar developing countries.

2. Risk Profiles and Covariance Between Them

The initial approach for risk handlings divided risk into ranges for three independent variables: capacity of production, capital cost, and construction time. It is clear that the independence assumption does not often hold. For many projects, the capacity of production is positively correlated to capital cost, while capital cost is also related to construction time. The use of the COVTNT variable as an attempt to relate construction time to capital cost is a positive conceptual step. In practice, it is difficult to evalute. The initial assumption of independence is due to the inability to easily model the relationship between the risk variables. It differs markedly across project types and even between similar projects. Even in the U.S., often little information is available on such a relationship. For some projects further investigation is needed to identify useable sources of information.

3. Operating Cost

The proposed method divides the formerly aggregated annual operation cost into three components: fixed annual costs, variable annual cost, and

labor. Labor is itself divided into four categories and energy cost is treated as a separate variable. Finally all of those categories are divided into foreign or local currency components. Like the disaggregation carried out for capital cost, this procedure permits a more accurate economic evaluation of the project; likewise, the procedure creates data gathering difficulty. On one level it is difficult to separate variable from fixed operating costs. The demarcation between the two categories is tenuous at best and requires a detailed investigation of all of the expenses occuring at a plant for a given year. On another level, the identification of imported versus local goods and labor is also problematic. Again, an indepth investigation might be needed for some projects.

Since for most projects the operating cost is minor compared to other cash flows, it might be optimal to rely in engineering judgement or assume percentage estimates based on other detailed studies.

D. Problems Specific to Projects

1. Gas Development Projects

There is a need to add two new variables to the energy product list: Meskala natural gas and Toukimt natural gas. The reason is the difference in chemical composition and calorific value between the two gases. Also it might be useful to create a new category called condensate rather than use the fuel oil one as is currently practiced.

On the engineering side, the gas development and transport projects need to be continually reviewed and updated based on the new ONAREP scenarios and changes in reserve estimates.

2. Fuel Switching Projects

Almost all gas or coal use projects are treated as costless conversions. There is an immediate need to develop more detail for these projects.

3. Shale Projects

Based on the information currently available, these projects have not been completely changed into the new format. New projects need to be developed based on the current TOSCO, Shell and World Bank engineering work on Moroccan shale.

4. Nuclear and Uranium Projects

The nuclear plants need to be reviewed based on the new time frame of the Moroccan nuclear program. The change should include the development of costs which are based on actual costs of plants built in the developing world.

5. Shale Oil Refining and Upgrading

The information used to develop these projects comes from U.S. engineering studies. A review similar to the one for shale retorting is necessary. It is, however, not critical at this point in time due to the status of the Moroccan shale program.

E. General Comments

All the projects need to be updated to 1983 or 1986 dollars. Most of them are based on 1980-1982 data. The use of a flexible exchange rate only takes into account the change in currency value. We need to update project cost estimates based on equipment inflation rates both in $ and local currency.

Labor rates need to be updated into more realistic estimates. Also causing problems is our fifty percent fringe benefit figure which seems too high and rigid an estimate. Benefits vary significantly across industry and skill level.

While an attempt was made to change the risk profile of all projects, the results are far from final. Expert opinion is needed to derive the risk profiles and it is important that the results are consistent both within a project and across the data base. Also, the risk profile of a technology changes over time as experience accumulated worldwide reduces the level of uncertainty.

F. Conclusion and Future Efforts

The data base as it stands is operational and can be effectively used for purposes of planning. However, it has suffered from past weaknesses. The main ones were:

a. too large a degree of aggregation and
b. old and questionable estimates.

The proposed change in variables should go a large way in remedying the problems encountered in the economic evaluation of projects. However, it requires a large increase in the number of key variables and demands a deeper and more rigorous project development process. The update of the data base is a crucial step at this point; the whole modeling process can be put in jeopardy by the use of old information. The procedure is time consuming but presents few conceptual difficulties.

The support given by MEM to the planning project has led to increased support from most of the actors in the Moroccan energy scene. A series of meetings, the building of official ties, and the use of technical memorandums as a communication device has led to a high level of involvement from the parastatals in the characterization. Such a step has led to a marked improvement in the database, and, if continued, will insure the continual updating of project information.

APPENDIX I

UPDATED PROJECT DATA BASE

ENERGY PROJECT DESCRIPTION

Project Name: Hydroelectric Dams (1981-1985)

Characterization Year: 1982

Description: This project consists of six hydro dams to be constructed during 1981 through 1985. Five of the dams (Ammougguez, Dchar El Oued, M'Jara, M'Dez, Matmata) are multi-purpose while one (El Menzel) is uniquely for energy production to provide a generating capacity of 839 MWe. Average annual output of electricity will be 1340 GW hours.

Energy Production:

Energy Type:	Units	Annual Amount
Electricity	GW.HRS	1,340
Total	GIGAJOULES	4,896,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Water Potential		
Total	GIGAJOULES	

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	7,241,000,000 DH
Foreign Exchange Component:	2,528,500,000 DH
Local Currency Component:	4,712,500,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April, 1983
Construction Time:	5 years
Distribution of Investment Over Time:	15,20,30,20,15%/Year
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	20,280,000 DH/yr
Foreign Exchange Component	50 %
Variable Operating Cost	0 DH
Foreign Exchange Component	- %

Labor Costs:	Cost DH	Person Year
Unskilled	709,000	96
Skilled	591,000	32
Supervisory and Professional	1,417,000	16
Office Support	886,000	16
Fringe and Benefits	1,829,586	

Energy Consumption Per Unit of Output:	0 TJ/Gw-hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	48	60	108
Operating Capacity (%)	57	100	133
Capital Cost (%)	90	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Hydro Electric Power Stations (1986-1990)

Characterization Year: 1981

Description: This project consists of eight hydroelectric generating stations to be completed between 1991 and 1995. All dams are for energy production only, with a total capacity of 347 MWe.

Energy Production:

Energy Type:	Units	Annual Amount
Electricity	GW.HRS	595
Total	GIGAJOULES	2,142,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Water Potential		
Total	GIGAJOULES	

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	2,577,900,000 DH
Foreign Exchange Component:	903,500,000 DH
Local Currency Component:	1,674,400,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	5 years
Distribution of Investment Over Time:	15,20,30,20,15%/Year
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	6,590,000 DH/yr
Foreign Exchange Component	50 %
Variable Operating Cost	0 DH
Foreign Exchange Component	- %

Labor Costs:	Cost DH	Person Year
Unskilled	947,200	128
Skilled	740,000	40
Supervisory and Professional	1,776,000	20
Office Support	1,110,000	20
Fringe and Benefits		

Energy Consumption Per Unit of Output:	0 TJ/Gw-hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	48	60	108
Operating Capacity (%)	57	100	133
Capital Cost (%)	90	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Construction of a Nuclear Power Plant

Characterization Year: 1981

Description: A one unit, 600 MWe nuclear power plant will be built on the coast. The cooling water for the plant will come from the ocean. Annual energy output will be 3574 GW hours of electricity.

Energy Production:

Energy Type:	Units	Annual Amount
Electricity	GW.HRS	3,574
Total	GIGAJOULES	12,866,400

Energy Consumption:

Energy Type:	Units	Annual Amount
U^{235}	Kilograms	596
Total	GIGAJOULES	49,802,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	7,800,000,000 DH
Foreign Exchange Component:	7,020,000,000 DH
Local Currency Component:	780,000,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	9 years
Distribution of Investment Over Time:	5,10,10,15,20,15,10,10,5%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	31,304,000 DH/yr
Foreign Exchange Component	70 %
Variable Operating Cost	7,826,000 DH
Foreign Exchange Component	70 %

Labor Costs:	Cost DH	Person Year
Unskilled	888,000	120
Skilled	1,110,000	60
Supervisory and Professional	5,328,000	60
Office Support	1,110,000	20
Fringe and Benefits	4,218,000	

Energy Consumption Per Unit of Output:	13.9345 TJ/Gw-hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	96	108	180
Operating Capacity (GJ/d)	21,150	35,250	38,770
Capital Cost (%)	85	100	200

ENERGY PROJECT DESCRIPTION

Project Name: Construction of Units 3 and 4 of Mohammedia Power Plant

Characterization Year: 1982

Description: Construction of 2 (150 MW) coal burning power plant units at Mohammedia. Power plant capital costs include initial investments and conversion costs to make units 3 and 4 capable of burning imported coal.

Energy Production:

Energy Type:	Units	Annual Amount
Electricity	GW.HRS	1,800
Total	GIGAJOULES	6,480,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Imported Coal	tonnes	695,305
Total	GIGAJOULES	17,510,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	1,859,000,000 DH
Foreign Exchange Component:	1,261,000,000 DH
Local Currency Component:	598,000,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	5 years
Distribution of Investment Over Time:	15,20,30,20,15%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	30,638,000 DH/yr
Foreign Exchange Component	50 %
Variable Operating Cost	7,660,000 DH
Foreign Exchange Component	50 %

Labor Costs:	Cost DH	Person Year
Unskilled	596,000	81
Skilled	596,000	32
Supervisory and Professional	2,862,650	32
Office Support	894,578	16
Fringe and Benefits		

Energy Consumption Per Unit of Output:	9.7278 TJ/Gw-hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	48	60	72
Operating Capacity (GJ/d)	11,800	17,750	20,700
Capital Cost (%)	90	100	115

ENERGY PROJECT DESCRIPTION

Project Name: Coal Burning Power Plant (500 MW)

Characterization Year: 1981

Description: Build a 500 MW coal burning power plant on the coast to replace shale burning units. The plant is constructed in two units of 250 MW each.

Energy Production:

Energy Type:	Units	Annual Amount
Electricity	GW.HRS	3,066
Total	GIGAJOULES	11,070,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Coal	tonnes	1,171,755
Total	GIGAJOULES	30,700,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	2,860,000,000 DH
Foreign Exchange Component:	2,145,000,000 DH
Local Currency Component:	715,000,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	4 years
Distribution of Investment Over Time:	20,30,30,20%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	25,405,000 DH/yr
Foreign Exchange Component	50 %
Variable Operating Cost	6,351,000 DH
Foreign Exchange Component	50 %

Labor Costs:	Cost DH	Person Year
Unskilled	999,000	135
Skilled	499,000	27
Supervisory and Professional	2,398,000	27
Office Support	749,000	14
Fringe and Benefits	2,327,000	

Energy Consumption Per Unit of Output:	10.013 TJ/Gw-hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	48	60	90
Operating Capacity (%)	85	100	110
Capital Cost (%)	90	100	120

ENERGY PROJECT DESCRIPTION

Project Name: Expansion of Bed Five at the Jerada Coal Mine

Characterization Year: 1982

Description: Expansion of bed five at the Jerada coal mine to begin in 1982 and reach maximum of 1.0 million tonnes annual production by 1986 from current 700,000 tonne level. Figures for mine output and utility costs are for the expansion project only, not the entire mine operation.

Energy Production:

Energy Type:	Units	Annual Amount
Coal	tonnes	300,000
Total	GIGAJOULES	8,481,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Electricity	MW Hours	5,511
Diesel	Liters	420,280
Gasaoline	Liters	25,200
Total	GIGAJOULES	37,332

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	390,000,000 DH
Foreign Exchange Component:	234,000,000 DH
Local Currency Component:	156,000,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	5 years
Distribution of Investment Over Time:	20,20,20,20,20%
Project Life:	10 years
Operating Cost:	
Fixed Operating Cost:	15,361,000 DH/yr
Foreign Exchange Component	50 %
Variable Operating Cost	10,241,000 DH
Foreign Exchange Component	50 %

Labor Costs:	Cost DH	Person Year
Unskilled	24,426,000	1,300
Skilled	2,250,000	125
Supervisory and Professional	2,310,000	35
Office Support	1,941,500	35
Fringe and Benefits	Included in Labor Rates.	

Energy Consumption Per Unit of Output:	TJ/Gw-hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	54	60	96
Operating Capacity (GJ/d)	7.1	14.1	15.5
Capital Cost (%)	90	100	200

ENERGY PROJECT DESCRIPTION

Project Name: Open New Bed at Jerada Coal Mine

Characterization Year: 1982

Description: Bed six of Jerada coal mine is expected to be opened to produce 1,000,000 tonnes of coal by 1995. Work is scheduled to begin in 1987. Production of 100,000 tonnes per year is expected to begin in 1988 or 1989. Production will increase at an annual rate of 200,000 tonnes per year until maximum million tonne per year production is reached.

Energy Production:

Energy Type:	Units	Annual Amount
Coal	tonnes	1,000,000
Total	GIGAJOULES	28,270,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Electricity	MW Hours	90,000
Diesel	Liters	1,250,000
Gasaoline	Liters	92,500
Total	GIGAJOULES	376,600

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	1,137,700,000 DH
Foreign Exchange Component:	715,000,000 DH
Local Currency Component:	422,700,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	6 years
Distribution of Investment Over Time:	15,15,20,20,15,15%
Project Life:	30 years
Operating Cost:	
Fixed Operating Cost:	42,588,000 DH/yr
Foreign Exchange Component	50 %
Variable Operating Cost	28,392,000 DH
Foreign Exchange Component	50 %

Labor Costs:	Cost DH	Person Year
Unskilled	50,940,000	2,500
Skilled	2,475,000	150
Supervisory and Professional	3,360,000	60
Office Support	555,000	10
Fringe and Benefits		

Energy Consumption Per Unit of Output:

3.272×10^{-3} liter gasoline/GJ coal

4.4216×10^{-3} liter diesel/GJ coal

3.183×10^{-6} GW-hr electric/GJ coal

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	60	72	108
Operating Capacity (GJ/d)	38,725	77,450	85,195
Capital Cost (%)	90	100	200

ENERGY PROJECT DESCRIPTION

Project Name: Develop Gas Field at Meskala

Characterization Year: 1982

Description: This project consists of drilling and completing 10 natural gas wells, each one 5 1/2" in diameter, to produce a total of 11.5 million cubic meters per day of gas. In addition, a natural gas plant would be built to separate condensate from the gas and cryogenically remove ethane, propane, and butane from the gas. The natural gas plant will consist of two 200 million ft^3/day trains. Estimated condensate production is 40,000 barrels/day.

Energy Production:

Energy Type:	Units	Annual Amount
Methane	1000 standard m^3	3,196,816
Ethane	1000 " "	502,021
Propane	1000 " "	172,937
Butane	1000 " "	73,876
Fuel Oil #1	barrels	14,600,000
Total	GIGAJOULES	245,398,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Natural Gas	1000 standard m^3	210,000
Total	GIGAJOULES	8,080,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	1,007,500,000 DH
Foreign Exchange Component:	806,000,000 DH
Local Currency Component:	201,500,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	3 years
Distribution of Investment Over Time:	30,40,30%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	12,480,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	3,120,000 DH
Foreign Exchange Component	50%

Labor Costs:	Cost DH	Person Year
Unskilled	1,840,000	250
Skilled	2,750,000	150
Supervisory and Professional	12,000,000	135
Office Support	1,800,000	30
Fringe and Benefits	9,195,000	

Energy Consumption Per Unit of Output:	.03293 GJ gas/GJ gas produced

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	30	36	72
Operating Capacity (GJ/d)	403,000	672,000	941,000
Capital Cost (%)	85	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Natural Gas Pipeline ($1X10^6$ m^3/Day Capacity)

Characterization Year: 1982

Description: Construct a 500 mile pipeline to deliver $1X10^6$ cubic meters of natural gas per day. Pipeline characterized is 12" diameter, 800 psi line with seven compressor stations.

Energy Production:

Energy Type:	Units	Annual Amount
Natural Gas	1000 m^3	350,000
Total	GIGAJOULES	13,500,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Natural Gas	1000 m^3	1,285
Total	GIGAJOULES	49,500

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	453,700,000 DH
Foreign Exchange Component:	385,645,000 DH
Local Currency Component:	68,645,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	4 years
Distribution of Investment Over Time:	20,30,30,20%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	5,730,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	1,432,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	3,430,000	460
Skilled	3,070,000	170
Supervisory and Professional	20,600,000	230
Office Support	3,690,000	70
Fringe and Benefits	15,390,000	

Energy Consumption Per Unit of Output:	3.6667×10^3 TJ Gas/TJ Gas

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	32	48	72
Operating Capacity (%)	90	100	110
Capital Cost (%)	90	100	150

ENERGY PROJECT DESCRIPTION

Project Name: Natural Gas Pipeline ($6X10^6$ m^3/Day Capacity)

Characterization Year: 1982

Description: Construct a 500 mile pipeline to deliver six million cubic meters of natural gas per day. Pipeline characterized is a 24" diameter, 1000 psi line with seven compressor stations.

Energy Production:

Energy Type:	Units	Annual Amount
Natural Gas	1000 m^3	2,100,000
Total	GIGAJOULES	80,300,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Natural Gas	1000 m^3	67,600
Total	GIGAJOULES	2,600,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	1,045,200,000 DH
Foreign Exchange Component:	888,550,000 DH
Local Currency Component:	156,550,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	4 years
Distribution of Investment Over Time:	20,30,30,20%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	8,148,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	2,037,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	3,430,000	460
Skilled	3,070,000	170
Supervisory and Professional	20,600,000	230
Office Support	3,690,000	70
Fringe and Benefits	15,390,000	

Energy Consumption Per Unit of Output:	3.238×10^{-2} TJ Gas/TJ Gas

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	42	48	78
Operating Capacity (%)	90	100	110
Capital Cost (%)	90	100	150

ENERGY PROJECT DESCRIPTION

Project Name: Natural Gas Pipeline ($3X10^6$ m^3/Day Capacity)

Characterization Year: 1982

Description: Construct a 500 mile pipeline to deliver three million cubic meters of natural gas per day. Pipeline characterized is a 18" diameter, 1000 psi line with six compressor stations.

Energy Production:

Energy Type:	Units	Annual Amount
Natural Gas	1000 m^3	1,050,000
Total	GIGAJOULES	40,520,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Natural Gas	1000 m^3	29,110
Total	GIGAJOULES	1,120,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	754,000,000 DH
Foreign Exchange Component:	640,900,000 DH
Local Currency Component:	113,100,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	4 years
Distribution of Investment Over Time:	20,30,30,20%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	5,824,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	1,456,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	2,940,000	398
Skilled	2,600,000	140
Supervisory and Professional	17,520,000	200
Office Support	3,170,000	56
Fringe and Benefits	13,120,000	

Energy Consumption Per Unit of Output:	2.764×10^{-2} TJ Gas/TJ Gas

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	40	48	78
Operating Capacity (%)	90	100	110
Capital Cost (%)	90	100	150

ENERGY PROJECT DESCRIPTION

Project Name: Natural Gas Pipeline ($11.5X10^6$ m^3/Day Capacity)

Characterization Year: 1982

Description: Construct a 500 mile pipeline to deliver 11.5 million cubic meters of natural gas per day. Pipeline characterized is 30" diameter, 1000 psi line with eight compressor stations.

Energy Production:

Energy Type:	Units	Annual Amount
Natural Gas	1000 m^3	4,033,677
Total	GIGAJOULES	155,300,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Natural Gas	1000 m^3	152,500
Total	GIGAJOULES	5,870,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	1,560,000,000 DH
Foreign Exchange Component:	1,326,000,000 DH
Local Currency Component:	234,100,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	5 years
Distribution of Investment Over Time:	15,20,30,20,15%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	8,568,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	962,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	3,930,000	530
Skilled	3,500,000	190
Supervisory and Professional	23,560,000	265
Office Support	4,210,000	76
Fringe and Benefits	17,600,000	

Energy Consumption Per Unit of Output:	.0378 TJ Gas/TJ Gas

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	48	60	96
Operating Capacity (%)	90	100	110
Capital Cost (%)	90	100	150

ENERGY PROJECT DESCRIPTION

Project Name: Coal Port

Characterization Year: 1982

Description: This project consists of expanding the port of Mohammedia or Jorf el Asfar in order to enable it to import 2,740 tonnes/day of coal. 2,192 tonnes/day of this coal will be fired in boilers 3 and 4 at the power plant.

Energy Production:

Energy Type:	Units	Annual Amount
Coal	tonnes	1,000,000
Total	GIGAJOULES	33,320,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Total	GIGAJOULES	0

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	156,000,000 DH
Foreign Exchange Component:	78,000,000 DH
Local Currency Component:	78,000,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	4 years
Distribution of Investment Over Time:	20,30,30,20%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	780,000 DH/yr
Foreign Exchange Component	50 %
Variable Operating Cost	780,000 DH
Foreign Exchange Component	50 %

Labor Costs:	Cost DH	Person Year
Unskilled	946,000	236
Skilled	350,000	35
Supervisory and Professional	1,261,000	26
Office Support	1,516,000	52
Fringe and Benefits	2,036,000	

Energy Consumption Per Unit of Output:	TJ/Gw-hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	42	48	60
Operating Capacity (GJ/d)	82,159	91,288	94,968
Capital Cost (%)	85	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Gas Condensate Pipeline (Meskala-Samir)

Characterization Year: 1982

Description: Construct a pipeline from Meskala to the Samir refinery in Mohammedia to transport natural gas condensate. The capacity of the pipeline will be 40,000 barrels per day for fuel oil #1. The 14" diameter, 350 mile line has two pumping stations.

Energy Production:

Energy Type:	Units	Annual Amount
Fuel Oil #1	Barrels	14,600,000
Total	GIGAJOULES	672,480,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Electricity	MW hrs	600
Total	GIGAJOULES	21,600

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	240,000,000 DH
Foreign Exchange Component:	221,000,000 DH
Local Currency Component:	39,000,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	2 years
Distribution of Investment Over Time:	50/50%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	4,417,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	491,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	740,000	100
Skilled	555,000	30
Supervisory and Professional	1,776,000	20
Office Support	555,000	10
Fringe and Benefits	1,739,000	

Energy Consumption Per Unit of Output:	8.9222×10^{-7} GW-Hr/TJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	20	24	48
Operating Capacity (%)	90	100	105
Capital Cost (%)	90	100	150

ENERGY PROJECT DESCRIPTION

Project Name: Natural Gas Fired Power Plant

Characterization Year: 1982

Description: Build a natural gas fired power plant on the coast to provide 300 MW of electricity. Power plant will consist of two units, 150 MWe each.

Energy Production:

Energy Type:	Units	Annual Amount
Electricity	GW-Hrs	1,840
Total	GIGAJOULES	6,624,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Gas	1000 m^3	491,075
Total	GIGAJOULES	18,900,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	2,210,000,000 DH
Foreign Exchange Component:	1,657,500,000 DH
Local Currency Component:	552,500,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	4 years
Distribution of Investment Over Time:	20,30,30,20%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	14,317,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	0 DH
Foreign Exchange Component	%

Labor Costs:	Cost DH	Person Year
Unskilled	488,400	66
Skilled	488,400	26
Supervisory and Professional	2,340,000	26
Office Support	732,600	13
Fringe and Benefits	2,020,000	

Energy Consumption Per Unit of Output:	10.2717TJ/GW-Hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	36	48	72
Operating Capacity (%)	85	100	110
Capital Cost (%)	90	100	150

ENERGY PROJECT DESCRIPTION

Project Name: Shale Mining at Timahdit

Characterization Year: 1982

Description: Mine 3 million tonnes of shale ore per year from Timahdit for consumption in the shale ore power plant. Assume shale ore will be strip-mined.

Energy Production:

Energy Type:	Units	Annual Amount
Share Ore	Tonnes	3,000,000
Total	GIGAJOULES	11,550,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Fuel Oil	Tonnes	12,272
Electricity	MW Hrs	27,300
Total	GIGAJOULES	624,160

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	1,834,690,000 DH
Foreign Exchange Component:	1,196,520,000 DH
Local Currency Component:	638,170,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	3 years
Distribution of Investment Over Time:	25,50,25%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	13,806,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	13,806,000 DH
Foreign Exchange Component	50%

Labor Costs:	Cost DH	Person Year
Unskilled	8,455,000	430
Skilled	900,000	50
Supervisory and Professional	2,640,000	40
Office Support	1,665,000	20
Fringe and Benefits	Included in Labor Costs	

Energy Consumption Per Unit of Output:	2.36×10^{-3} GW-Hr/TJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	24	36	48
Operating Capacity (%)	75	100	110
Capital Cost (%)	90	100	200

ENERGY PROJECT DESCRIPTION

Project Name: Direct Combustion of Shale to Produce Electric Power (Fluid Bed Combustor)

Characterization Year: 1982

Description: This project will produce power by direct combustion of Timahdit shale in a fluid bed boiler. The power plant will be 200 MW.

Energy Production:

Energy Type:	Units	Annual Amount
Electricty	GW-Hrs	1,050
Total	GIGAJOULES	3,780,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Shale Ore	Tonnes	3,039,200
Total	GIGAJOULES	11,700,920

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	2,483,000,000 DH
Foreign Exchange Component:	1,862,250,000 DH
Local Currency Component:	620,750,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	5 years
Distribution of Investment Over Time:	15,20,30,20,15%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	88,765,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	22,191,000 DH
Foreign Exchange Component	50%

Labor Costs:	Cost DH	Person Year
Unskilled	799,200	108
Skilled	330,000	18
Supervisory and Professional	621,600	7
Office Support	277,500	5
Fringe and Benefits	1,015,650	

Energy Consumption Per Unit of Output:	11,1438TJ/GW-Hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	40	60	96
Operating Capacity (%)	67	100	125
Capital Cost (%)	90	100	150

ENERGY PROJECT DESCRIPTION

Project Name: Direct Combustion of Shale Ore (Conventional Combustor)

Characterization Year: 1982

Description: This project is to produce power by direct combustion of Timahdit shale ore in a conventional pulverized fuel combustor to produce 200 MW electricity at Timahdit.

Energy Production:

Energy Type:	Units	Annual Amount
Electricty	GW-Hrs	1,050
Total	GIGAJOULES	3,780,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Shale Ore	Tonnes	3,039,200
Electricity	MW Hrs	27,300
Total	GIGAJOULES	11,700,920

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	2,293,200,000 DH
Foreign Exchange Component:	1,719,900,000 DH
Local Currency Component:	573,300,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	5 years
Distribution of Investment Over Time:	15,20,30,20,15%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	88,765,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	22,191,000 DH
Foreign Exchange Component	50%

Labor Costs:	Cost DH	Person Year
Unskilled	799,200	108
Skilled	333,000	18
Supervisory and Professional	621,600	7
Office Support	277,500	5
Fringe and Benefits	1,015,650	

Energy Consumption Per Unit of Output:	11.1438TJ/GW-Hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	40	60	96
Operating Capacity (%)	67	100	125
Capital Cost (%)	90	100	150

ENERGY PROJECT DESCRIPTION

Project Name: Shale Oil Upgrading Facilities (10,000 Barrel Per Day)

Characterization Year: 1982

Description: This project consists of the construction of a shale oil upgrading facility that will produce 10,000 barrels per day of synthetic crude suitable for refining in a conventional refinery. The plant includes the following facilities: hydrotreater, hydrogen manufacturer, wastewater treatment, hydrogen sulfide recovery, and sulfur production. It is assumed that the facility operates 24 hours per day, 350 days per year.

Energy Production:

Energy Type:	Units	Annual Amount
Synthetic Crude	Barrels	3,500,000
	Tonnes	517,650
Total	GIGAJOULES	24,325,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Coal	Tonnes	7,780
Shale	Tonnes	807,100
Total	GIGAJOULES	25,877,700

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	1,053,000,000 DH
Foreign Exchange Component:	789,750,000 DH
Local Currency Component:	263,250,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	2 years
Distribution of Investment Over Time:	50,50%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	29,469,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	7,367,000 DH
Foreign Exchange Component	50%

Labor Costs:	Cost DH	Person Year
Unskilled	240,000	32
Skilled	120,000	7
Supervisory and Professional	576,000	7
Office Support	180,000	3
Fringe and Benefits	558,000	

Energy Consumption Per Unit of Output:	.31984 Tonne/TJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	20	24	36
Operating Capacity (%)	80	100	110
Capital Cost (%)	95	100	120

ENERGY PROJECT DESCRIPTION

Project Name: Shale Oil Upgrading Facility (50,000 Barrel Per Day)

Characterization Year: 1982

Description: This project consists of the construction of a shale oil upgrading facility that will produce 50,000 barrels per day of synthetic crude. The plant includes the following facilities: hydrotreater, hydrogen manufacturer, wastewater treatment, hydrogen sulfide recovery, sulfur production, tail-gas treatment and off-plant facilities.

Energy Production:

Energy Type:	Units	Annual Amount
Synthetic Crude	Barrels	17,500,000
	Tonnes	2,588,000
Total	GIGAJOULES	121,625,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Coal	Tonnes	38,910
Shale Oil	Tonnes	4,035,500
Total	GIGAJOULES	129,388,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	2,997,800,000 DH
Foreign Exchange Component:	2,248,350,000 DH
Local Currency Component:	749,450,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	3 years
Distribution of Investment Over Time:	25,50,25%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	147,247,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	36,837,000 DH
Foreign Exchange Component	50%

Labor Costs:	Cost DH	Person Year
Unskilled	694,000	94
Skilled	347,000	19
Supervisory and Professional	1,665,600	19
Office Support	520,500	9
Fringe and Benefits	1,613,500	

Energy Consumption Per Unit of Output:	.31992 Tonne/TJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	30	36	48
Operating Capacity (%)	80	100	110
Capital Cost (%)	95	100	120

ENERGY PROJECT DESCRIPTION

Project Name: Shale Oil Refinery (50,000 Barrel Per Day)

Characterization Year: 1981

Description: This project will produce 50,000 barrels per day of light petroleum products (LPG, jet fuel, diesel, motor gasoline) from Moroccan shale oil. The plant uses the Chevron Process to hydrotreat and hydrocrack the shale oil. On site facilities include: hydrotreater, hydrocracker, reformer, wastewater treatment, and H_2S recovery. Off site facilities include a power plant, cooling tower, site development, and storage and delivery facilities. Plant is accessed to operate 350 days per year, 24 hours per day.

Energy Production:

Energy Type:	Units	Annual Amount
Gasoline	Barrels	3,211,250
Diesel	Barrels	10,459,800
Kerosene	Barrels	3,829,000
Total	GIGAJOULES	104,002,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Shale Oil	Barrels	21,566,000
Coal	Tonnes	47,000
Total	GIGAJOULES	110,344,000

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	4,387,400,000 DH
Foreign Exchange Component:	3,290,300,000 DH
Local Currency Component:	1,097,206,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	3 years
Distribution of Investment Over Time:	25,50,25%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	241,769,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	60,442,000 DH
Foreign Exchange Component	50%

Labor Costs:	Cost DH	Person Year
Unskilled	1,209,600	164
Skilled	604,800	33
Supervisory and Professional	2,903,040	33
Office Support	907,200	12
Fringe and Benefits	2,812,320	

Energy Consumption Per Unit of Output:	4.519×10^{-4} Tonne/GJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	30	36	54
Operating Capacity (%)	80	100	110
Capital Cost (%)	90	100	120

ENERGY PROJECT DESCRIPTION

Project Name: Shale Oil Refinery (10,000 Barrel Per Day)

Characterization Year: 1982

Description: This project will produce 10,000 barrels per day of light petroleum products (LPG, jet fuel, diesel, motor gasoline) from Moroccan shale oil. The plant uses the Chevron Process to hydrotreat and hydrocrack the shale oil. On site facilities include: hydrotreater, hydrocracker, reformer, wastewater treatment, and H_2S recovery. Off site facilities include a power plant, cooling tower, site development, and storage and delivery facilities. Plant is accessed to operate 350 days per year, 24 hours per day.

Energy Production:

Energy Type:	Units	Annual Amount
Gasoline	Barrels	642,250
Diesel	Barrels	2,091,950
Kerosene	Barrels	765,800
Total	GIGAJOULES	20,800,400

Energy Consumption:

Energy Type:	Units	Annual Amount
Shale Oil	Barrels	4,313,200
Coal	Tonnes	9,400
Total	GIGAJOULES	22,068,800

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	1,570,400,000 DH
Foreign Exchange Component:	1,177,800,000 DH
Local Currency Component:	392,600,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	2 years
Distribution of Investment Over Time:	50,50%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	54,712,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	13,678,000 DH
Foreign Exchange Component	50%

Labor Costs:	Cost DH	Person Year
Unskilled	504,000	68
Skilled	252,000	14
Supervisory and Professional	1,209,600	14
Office Support	378,000	7
Fringe and Benefits	1,171,500	

Energy Consumption Per Unit of Output:	4.510×10^{-4} Tonne/GJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	22	24	31
Operating Capacity (%)	80	100	110
Capital Cost (%)	80	100	120

ENERGY PROJECT DESCRIPTION

Project Name: Forestry Project (30,000 Hectares)

Characterization Year: 1981

Description: This five year project consists of (1) destumping and replanting of about 20,000 hectares of existing low-yielding Eucalyptus plantations in the Mamora and Gharb areas; (2) reforestation of the mamora forest area of about 10,000 hectares degraded cork Oak forest with 3,500 hectares Eucalyptus, 3,500 hectares Acacia mollissima and 3,500 hectares of pines; (3) upgrading and constructing of approximately 140 and 40 km of forest roads and tracks, and maintaining about 500 km of selected plantation roads over the project construction period; (4) pasture improvement on about 2,600 hectares; (5) improving the research, forest inventory/planning and training capabilities of DEFCS; (6) carrying out specialized studies including forest inventory, management, exploitation (charcoal) and financing; and (7) establishment of a project management unit together with technical, administrative and local support.

Energy Production:

Energy Type:	Units	Annual Amount
Wood	M^3	88,460
Total	GIGAJOULES	1,100,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Total	GIGAJOULES	0

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	32,696,000 DH
Foreign Exchange Component:	13,650,000 DH
Local Currency Component:	19,046,200 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	5 years
Distribution of Investment Over Time:	20,20,20,20,20%
Project Life:	35 years
Operating Cost:	
Fixed Operating Cost:	6,201,000 DH
Foreign Exchange Component	10%
Variable Operating Cost	0 DH
Foreign Exchange Component	0%

Labor Costs:	Cost DH	Person Year
Unskilled	3,800,000	515
Skilled	185,000	10
Supervisory and Professional	266,400	3
Office Support		
Fringe and Benefits	2,125,700	

Energy Consumption Per Unit of Output:	0 TJ/GW-Hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	54	69	78
Operating Capacity (%)	2100	3000	3300
Capital Cost (%)	95	100	150

ENERGY PROJECT DESCRIPTION

Project Name: Fuel Wood Production (60,000 Hectares)

Characterization Year: 1981

Description: To maintain the current maximum allowable wood at 3 million m^3/year, an average annual planting program of 60,000 hectares will have to be carried out. In addition to planting trees, roads and fire-breaks must be built.

Energy Production:

Energy Type:	Units	Annual Amount
Wood	M^3	3,000,000
	Tonnes	1,800,000
Total	GIGAJOULES	36,360,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Total	GIGAJOULES	0

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	5,866,900,000 DH
Foreign Exchange Component:	1,872,000,000 DH
Local Currency Component:	3,994,900,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	15 years
Distribution of Investment Over Time:	6.67%/Yr
Project Life:	45 years
Operating Cost:	
Fixed Operating Cost:	186,030,000 DH
Foreign Exchange Component	10%
Variable Operating Cost	DH
Foreign Exchange Component	%

Labor Costs:	Cost DH	Person Year
Unskilled	174,720,000	14,200
Skilled	47,040,000	2,000
Supervisory and Professional	322,560	4
Office Support		
Fringe and Benefits	111,041,200	

Energy Consumption Per Unit of Output:	0 TJ/GW-Hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	162	180	234
Operating Capacity (%)	30	100	110
Capital Cost (%)	90	100	470

ENERGY PROJECT DESCRIPTION

Project Name: Alfa Project

Characterization Year: 1981

Description: Harvest and burn alfa in a 3 MWe thermal plant near Oujda.

Energy Production:

Energy Type:	Units	Annual Amount
Electricity	GW-Hrs	17.87
Total	GIGAJOULES	64,332

Energy Consumption:

Energy Type:	Units	Annual Amount
Alfa	GJ	645,720
	Tonnes	38,564
Total	GIGAJOULES	645,720

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	28,899,000 DH
Foreign Exchange Component:	23,140,000 DH
Local Currency Component:	5,759,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	2 years
Distribution of Investment Over Time:	50,50%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	250,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	0 DH
Foreign Exchange Component	0%

Labor Costs:	Cost DH	Person Year
Unskilled	88,800	12.3
Skilled	111,000	6.0
Supervisory and Professional	88,000	1
Office Support	0	
Fringe and Benefits	144,300	

Energy Consumption Per Unit of Output:	36.13TJ/GW-Hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	24	30	40
Operating Capacity (%)	50	100	105
Capital Cost (%)	90	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Photovoltaic Pumping

Characterization Year: 1981

Description: A 3 KW photovoltaic pumping system will replace a diesel engine to irrigate two to ten hectare farms. Wells are assumed to be twenty meters deep. Pumpsets will provide water for irrigation at a rate of 4 l/sec or about 70 m^3/day. If needed, a storage reservoir can be built to store a day's water requirements to that farmers may irrigate their crops at non-peak solar hours. It is assumed that 200 days of irrigation are required. The total project assumes fifteen pumping stations will be constructed.

Energy Production:

Energy Type:	Units	Annual Amount
Electricity	MW-Hrs	36
Total	GIGAJOULES	0

Energy Consumption:

Energy Type:	Units	Annual Amount
Sunshine		
Total	GIGAJOULES	0

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	4,953,000 DH
Foreign Exchange Component:	4,550,000 DH
Local Currency Component:	403,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	1 years
Distribution of Investment Over Time:	100%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	11,050 DH/Yr
Foreign Exchange Component	30%
Variable Operating Cost	0 DH
Foreign Exchange Component	0%

Labor Costs:	Cost DH	Person Year
Unskilled	1,720	1.2
Skilled	1,200	.33
Supervisory and Professional		
Office Support		
Fringe and Benefits		

Energy Consumption Per Unit of Output:	0 TJ/GW-Hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	6	8	15
Operating Capacity (%)	80	100	115
Capital Cost (%)	70	100	170

ENERGY PROJECT DESCRIPTION

Project Name: Rural Electrification (Photovoltaic Systems)

Characterization Year: 1981

Description: A 6 KW photovoltaic array and battery storage system will provide the electricity required for a village of 100 homes (600 people) that is isolated from the grid. The system was designed to provide electricity for 20 watts of light per home (fluorescent lights); electric motors to pump potable water (for people and livestock); 1 radio telephone; 1 television; 1 refrigerator (for medical supplies); and assorted appliances (radios, etc.). THe cost of the system includes 3 km of grid. The photovoltaic system is assumed to replace a 6.25 hp diesel generator.

Energy Production:

Energy Type:	Units	Annual Amount
Electricity	MW-Hrs	60
Total	GIGAJOULES	216

Energy Consumption:

Energy Type:	Units	Annual Amount
Sunshine		
Total	GIGAJOULES	0

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	7,039,000 DH
Foreign Exchange Component:	5,947,000 DH
Local Currency Component:	1,092,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	1 years
Distribution of Investment Over Time:	100%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	6,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	0 DH
Foreign Exchange Component	0%

Labor Costs:	Cost DH	Person Year
Unskilled	2,080	.3
Skilled	800	.043
Supervisory and Professional		
Office Support		
Fringe and Benefits		

Energy Consumption Per Unit of Output:	0 TJ/GW-Hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	8	10	20
Operating Capacity (%)	80	100	115
Capital Cost (%)	70	100	180

ENERGY PROJECT DESCRIPTION

Project Name: Oil and Gas Exploration

Characterization Year: 1981

Description: This is a research project to continue exploration for oil and gas in Morocco. The costs do not include the development of an oil field, should one be found.

Energy Production:

Energy Type:	Units	Annual Amount
Oil		Variable
Gas		Variable
Total	GIGAJOULES	

Energy Consumption:

Energy Type:	Units	Annual Amount
Total	GIGAJOULES	

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	2,346,500,000 DH
Foreign Exchange Component:	1,300,000,000 DH
Local Currency Component:	1,046,500,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	5 years
Distribution of Investment Over Time:	20,20,20,20,20%
Project Life:	__ years
Operating Cost:	
Fixed Operating Cost:	47,268,000 DH/Yr
Foreign Exchange Component	70%
Variable Operating Cost	0 DH
Foreign Exchange Component	0%

Labor Costs:	Cost DH	Person Year
Unskilled	2,060,000	250
Skilled	5,600,000	280
Supervisory and Professional	11,520,000	120
Office Support	4,290,000	70
Fringe and Benefits	11,730,000	

Energy Consumption Per Unit of Output:	TJ/GW-Hr

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)			
Operating Capacity (%)			
Capital Cost (%)			

ENERGY PROJECT DESCRIPTION

Project Name: Toukimt to Asmar Pipe Line

Characterization Year: 1983

Description: Gas pipe line to carry gas from Toukimt to Asmar. Capacity is 100,000 m^3/day. Pipe diameter is 6 inches.

Energy Production:

Energy Type:	Units	Annual Amount
Natural Gas	$1000m^3$	35,000
Total	GIGAJOULES	1,798,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Natural Gas	$1000m^3$	539
Total	GIGAJOULES	27,635

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	46,000,000 DH
Foreign Exchange Component:	39,000,000 DH
Local Currency Component:	7,000,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	1 year
Distribution of Investment Over Time:	100%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	738,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	185,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	350,200	47
Skilled	263,000	14
Supervisory and Professional	1,686,100	19
Office Support	260,000	5
Fringe and Benefits	1,279,000	

Energy Consumption Per Unit of Output:	1.537×10^{-2} TJ/TJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	12	15	24
Operating Capacity (%)	85	100	120
Capital Cost (%)	85	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Expansion of Toukimt-Asmar Gas Pipeline

Characterization Year: 1983

Description: Increase the capacity of the Toukimt gas pipeline from 100,000 m^3/day to 250,000 m^3/day. This will be achieved by adding 600 hp of compression to the original compressor station.

Energy Production:

Energy Type:	Units	Annual Amount
Natural Gas	$1000m^3$	52,560
		Additional
Total	GIGAJOULES	2,697,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Natural Gas	$1000m^3$	809
Total	GIGAJOULES	41,542

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	4,350,000 DH
Foreign Exchange Component:	3,698,000 DH
Local Currency Component:	651,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	1 year
Distribution of Investment Over Time:	100%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	31,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	8,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	67,100	9
Skilled	56,400	3
Supervisory and Professional	355,000	4
Office Support	52,100	1
Fringe and Benefits	265,300	

Energy Consumption Per Unit of Output:	1.54×10^{-2} TJ/TJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	3	6	12
Operating Capacity (%)	85	100	110
Capital Cost (%)	85	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Meskala to Benguerir Gas Line

Characterization Year: 1983

Description: Build gas line 20 inches in diameter from Meskala to Benguerir. The line will be 146 miles long and will reach Benguerir by going through Safi and Youssoufia. Initial energy consumption will be 384,000m^3/day.

Energy Production:

Energy Type:	Units	Annual Amount
Natural Gas	1000m^3	134,554
Total	GIGAJOULES	5,502,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Natural Gas	1000m^3	216
Total	GIGAJOULES	11,075

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	384,000,000 DH
Foreign Exchange Component:	326,300,000 DH
Local Currency Component:	57,700,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	2 years
Distribution of Investment Over Time:	50,50%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	1,645,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	411,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	350,200	47
Skilled	263,000	14
Supervisory and Professional	1,686,000	19
Office Support	260,500	5
Fringe and Benefits	1,279,900	

Energy Consumption Per Unit of Output:	2.01×10^{-3} TJ/TJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	18	24	36
Operating Capacity (%)	85	100	133
Capital Cost (%)	80	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Expansion of Meskala-Benguerir Gas Line

Characterization Year: 1983

Description: Expansion of the 20 inch gas line from Meskala to Benguerir. The expansion will be 109 miles long from Benguerir to Mohammedia, passing through Casablanca. Additional capacity will be 2,228,000 m^3.

Energy Production:

Energy Type:	Units	Annual Amount
Natural Gas	$1000m^3$	780,691
Total	GIGAJOULES	31,923,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Natural Gas	$1000m^3$	6,493
Total	GIGAJOULES	332,680

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	310,800,000 DH
Foreign Exchange Component:	263,900,000 DH
Local Currency Component:	46,900,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	2 years
Distribution of Investment Over Time:	50,50%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	1,406,000 DH
Foreign Exchange Component	30%
Variable Operating Cost	1,757,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	629,800	85
Skilled	491,400	26
Supervisory and Professional	3,446,900	39
Office Support	596,700	11
Fringe and Benefits	2,585,700	

Energy Consumption Per Unit of Output:	1.042×10^{-2} TJ/TJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	18	24	36
Operating Capacity (%)	85	100	120
Capital Cost (%)	80	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Gas Condensate Pipeline (Meskala to Samir)

Characterization Year: 1983

Description: Build gas condensate pipeline that will be 9400 barrel/day to carry condensate from the Meskala gas field to the Samir refinery at Mohammedia. Pipeline length will be 350 miles and 10 inches in diameter. Two 150 hp compressors will be necessary.

Energy Production:

Energy Type:	Units	Annual Amount
Condensate	Tonne	381,370
Total	GIGAJOULES	17,596,000

Energy Consumption:

Energy Type:	Units	Annual Amount
Electricity	GW-Hr	.4
Total	GIGAJOULES	1,440

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	226,000,000 DH
Foreign Exchange Component:	183,300,000 DH
Local Currency Component:	45,700,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	2 years
Distribution of Investment Over Time:	50,50%
Project Life:	40 years
Operating Cost:	
Fixed Operating Cost:	3,972,000 DH/Yr
Foreign Exchange Component	30%
Variable Operating Cost	993,000 DH
Foreign Exchange Component	30%

Labor Costs:	Cost DH	Person Year
Unskilled	559,000	76
Skilled	702,000	38
Supervisory and Professional	1,599,000	18
Office Support	546,000	10
Fringe and Benefits	1,703,000	

Energy Consumption Per Unit of Output:	2.31×10^{-3} TJ/TJ

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	20	24	36
Operating Capacity (%)	80	100	120
Capital Cost (%)	85	100	133

ENERGY PROJECT DESCRIPTION

Project Name: Uranium Extraction Unit

Characterization Year: 1983

Description: This project consists of the construction of a uranium extraction unit. The plant separates uranium from teh phosphoric acid making process stream. Capacity is 150 tonnes/year of uranium and the unit should be on line in 1985.

Energy Production:

Energy Type:	Units	Annual Amount
Uranium	Tonne	150
Total	GIGAJOULES	

Energy Consumption:

Energy Type:	Units	Annual Amount
Electricity	GW-Hr	18,396
Total	GIGAJOULES	66,225

ECONOMIC AND RISK ASSESSMENT

Economic Assessment

Capital Cost:	
Total Project Capital Cost:	500,000,000 DH
Foreign Exchange Component:	349,700,000 DH
Local Currency Component:	150,300,000 DH
Exchange Rate:	6.5 DH/$
Exchange Determination Date:	April 1983
Construction Time:	3 years
Distribution of Investment Over Time:	25,50,25%
Project Life:	20 years
Operating Cost:	
Fixed Operating Cost:	8,000,000 DH
Foreign Exchange Component	50%
Variable Operating Cost	2,000,000 DH
Foreign Exchange Component	50%

Labor Costs:	Cost DH	Person Year
Unskilled	148,000	20
Skilled	2,220,000	120
Supervisory and Professional	444,000	5
Office Support	277,500	5
Fringe and Benefits	1,519,500	

Energy Consumption Per Unit of Output:	.12264GW-Hr/Tonne

Risk Assessment

	Minimum	Expected	Maximum
Construction Time (Months)	30	36	42
Operating Capacity (%)	80	100	110
Capital Cost (%)	85	100	120

OCP Conversion Project

Description: The conversion project consists of implementing a fuel switch from fuel oil to gas in all OCP installations in the Safi-Youssoufia-Benguerir area. Gas will be supplied from Meskala through a 20 inch pipe.

Production: Phosphate production in Morocco is 19.272×10^6 tonne /year(1)

Old Energy Use Coefficients:

Gas: 2.429×10^{-3} $1000m^3$/tonne phosphate
Diesel: 2.453×10^{-6} tonne /tonne phosphate
Fuel Oil: 1.3776×10^{-5} tonne /tonne phosphate
Elect.: 1.0531×10^{-5} GWhr/tonne phosphate

Coefficient Change:

Gas consumption is calculated based on 1100 BTU/ft^3
Gas will replace 120,000 tonnes of fuel oil
Gas consumption will be equivalent to $134,500 \times 10^3$ m^3/year

New Energy Use Coefficients:

Gas: 9.41×10^{-3} $1000m^3$/tonne phosphate
Diesel: 2.453×10^{-6} tonne/tonne phosphate
Fuel Oil: $.7546 \times 10^{-2}$ tonne/tonne phosphate
Electric: 1.0531×10^{-5}GWhr/tonne phosphate

Notes: (1) Based on 1978 Production Data

Lafarge Cement Plant Conversion

Description: The Lafarge cement plant produces 840,000 tonnes of cement per year. It operates through a wet process and burns fuel oil. The conversion project aims at replacing fuel oil as the main energy source with natural gas from the Meskala gas field.

Production: Lafarge is one of two plants operating under a wet process. The sector's production was 1.32×10^6 tonnes/year of which Lafarge produced 63.64%(1).

Old Energy Use Coefficients:

Fuel Oil: .1221 tonne/tonne cement
Electricity: 1.0287×10^{-4} GWhr/tonne cement

Coefficient Change: Gas consumption is calculated based on 1100BTU/ft^3. It replaces fuel oil based on calorific content equivalence.

New Energy Use Coefficients:

Natural Gas: $.1061 \times 10^3 m^3$/tonne cement
Fuel Oil: .0444 tonne/tonne cement
Electricity: 1.0287×10^{-4} GWhr/tonne cement

Notes: (1) Based on first quarter 1981 production figures.