PD-AAQ-590 37897

A DESIGN FOR A NATIONAL ENERGY ASSESSMENT

for

the

DEMOCRATIC REPUBLIC OF THE SUDAN

Alan B. Jacobs - U.S. Agency for International Deveopment

Philip F. Palmedo - Energy/Development International

Asif M. Shaikh - Energy/Development International

U.S. Agency for International Development

TABLE OF CONTENTS

		Page
I	INTRODUCTION	1
	A. Background	1
	B. Structure of this Paper	2
II	ENERGY AND RELATED ISSUES	2
	A. Economic and Energy Context	2
	1. Economy	2
	2. Energy Pattern	4
	B. Energy Related Issues	5
	1. Balance of Payments	5
	2. Effects of Shortages on Prices and Production	6
	3. Rural Energy Needs	8
	4. Energy for Economic and Industrial Development	9
	5. Electricity Supply	10
	6. Transport and Energy	11
III	PROJECT ELEMENTS	12
	A. Supply - Demand Analysis	12
	1. Data Collection on Energy Use	12
	2. Demand Projections	13
	3. Resource Evaluation	14
	4. Reference Supply - Demand Balances	14
	B. Strategy Analysis	14
	1. Energy from Biomass	15
	2. Alternative Energy Use in Agriculture	15
	3. Energy for Rural Households and Small Scale Industry	15
	4. Energy for Transportation	15
	5. Industrial Energy Requirements	15
	6. Urban Energy Requirements	15
	7. Electricity Supply	16
	8. Pricing	16
	C. Policy Analysis	16
	D. Institutional Development	17
IV	PROJECT IMPLEMENTATION	17
	A. Government Participation	17
	B. Level of Effort and Schedule	18

INTRODUCTION

A. Background

Sudan is faced with critical energy problems. In recognition of this situation a Ministry of Energy and Mining has been created in order to focus on energy and its importance to development and modernization of the nation. To strengthen this focus on energy problems the Minister of Energy believes that an overall examination of Sudan's current and future energy requirements is necessary to better understand the implications of energy in National Development and to determine what action would improve its energy situation.

The Minister of Energy had seen various approaches to the preparation of comprehensive country energy studies, including one prepared for Egypt by a team organized by the U.S. Department of Energy. This resulted in the Minister asking the U.S. Ambassador if the U.S. Government could be of assistance in preparing an overall assessment of the energy situation in the Sudan. This inquiry was forwarded to Washington with the Embassy's endorsement.

Meetings between the U.S. Agency for International Development (AID), Department of State and the Department of Energy resulted in an agreement that assistance would be provided by AID, funded and directed by AID's Office of Energy. Following the decision to undertake a Sudan Energy Study it was agreed that before embarking on the full scale study it would be wise to send a preparatory team to the Sudan to determine, in collaboration with Sudanese and U.S. officials, what should be included in the study and how it should be undertaken.

A team composed of Alan Jacobs, AID Office of Energy, Philip Palmedo and Asif Shaikh, Energy/Development International, was formed to undertake preliminary project analysis, to prepare a statement of goals and objectives and preliminary estimates of time and personnel necessary for the completion of the larger program.

The team's collective experience in energy and development matters coupled with the observations and advice of a range of Sudanese specialists has resulted in the following outline and narrative describing the team's observations and recommendations for the larger task to follow.

B. Structure of this Paper

The design of a national energy assessment should be based on the critical energy issues facing the country. The assessment should be designed to provide a systematic factual basis of improving energy decisions. Accordingly, this paper has three further sections. Section II identifies the major energy and energy-related issues facing the Sudan. Based on that appraisal, the section following it specifies the major elements of the national energy assessment. The final section of the report discusses practical matters of project implementation, personnel requirements, and schedule.

II. ENERGY AND RELATED ISSUES

A. Economic and Energy Context

1. Economy

While the population of Sudan is under twenty million, its land area is the largest in Africa (one million square miles). The climate ranges from tropical in the South to extremely arid in the Northern desert. Rainfed land is abundant in the South and Southwest, while the Nile River and the White and Blue Niles constitute the principal life-sustaining arteries above the twelfth parallel.

The dominant economic sectors are agriculture and herding, which employ a majority of the country's population, contribute the largest share of GDP, provide virtually all exports and, in addition, are the cornerstone of the nation's development strategy.

In addition to traditional small-owner farming, Sudan has undertaken vast, modern, commercial agricultural projects as part of an export-oriented, agriculturally-based growth effort. These include projects at Kenana, Sennar, Rahad, Blue Nile, Assalaya, Damizene, Ghezira and others.

The industrial sector is not yet well-developed, and is still characterized by the predominance of import-substitution activities. However, increased emphasis is being placed on export industry, particularly in agricultural/livestock processing, with major new private or public investment foreseen in Khartoum, Ghezira, Wad Medani and Port Sudan.

The Sudan has important mineral and energy resources potential, much of which has remained under-utilized due to foreign exchange and infrastructure constraints. At present, only a small portion of iron, copper, chrome and gold deposits are being mined. Gypsum and asbestos are targeted for future investment. Natural gas has been found in the Red Sea area, although the quantities are not yet sufficient to warrant the development of an industrial and infra-structural enclave. The U.S. oil company "Chevron" has recently discovered commercial quantities of high quality light crude oil in exploration wells in the Southwestern portions of the country. Quantities are now sufficient only for a "mini-refinery" of 5,000-6,000 barrels per day (15-20% of national needs), but prospects for further discoveries seem reasonable.

Tables 1 and 2 summarize several key aspects of the Sudanese economy

Amongst the principal factors which continue to inhibit the realization of Sudan's considerable economic potential are its vast size, the wide disper-sion of centers of population and economic activity,

inadequate infrastructure, foreign exchange shortages intensified by an import-dependent economic structure and managerial shortcomings in certain important economic sub-sectors.

2. Energy Patterns

The two principal energy forms used in Sudan are wood and petroleum. From a quantitative perspective, the major energy source is firewood. It provides the fuel for cooking and domestic activities for virtually all rural households, and constitutes approximately sixty percent of total energy consumption. Wood and charcoal together account for over seventy percent of energy use. The second most important energy source in the country, and the principal commercial fuel, is petroleum and petroleum products. With the exception of hydropower used for a portion of electricity generation, and a small amount of bagasse, petroleum products supply virtually all modern sector energy requirements, including the energy used in transport, modern industry and processing and mechanized agriculture. Table 3 provides preliminary data - gathered by the Institute for Energy Research of the National Research Council - on energy use by sector and by fuel source. These data are very preliminary and appear to require adjustment in certain areas, such as the figures on energy consumed in electricity generation. Nevertheless, the table clearly identifies the preponderance of two fuel sources in Sudan's energy demand pattern: wood and petroleum. The principal economic/energy issues associated with each of these two fuel types are very different in their nature and impact. These issues are explored in Section B.

On the supply side, the only major indigenous energy sources that are currently being used are wood and hydropower. Wood supply and demand balances are

clearly not in long-term equilibrium. This has not yet produced any effective use of alternative fuels, but the disequilibrium manifests itself by the increased inaccessibility of firewood and by growing environmental degradation around population centers.

The Sudan is rich in resources which have the potential for providing liquid commercial fuels from renewable sources. An example of these are agricultural products and wastes, such as dura, cotton stalks, peanut shells and so on, as well as the very large quantities of sugar by-products - especially molasses - now being wasted at sugar factories in Kenana, Sennar, Assalaya, El Guneid and New Halfa. Prefeasibility assessments suggest that it would be economic - given the high cost of petroleum and the low opportunity cost of molasses - to produce enough alcohol for a 20% alcohol mix for all vehicle consumption.

B. Energy Related Issues

1. Balance of Payments

Sudan faces an extreme foreign exchange shortage, which has worsened over the last two years. Severe balance of payments problems are expected to continue - although with some easing - over the next several years. The current account deficit in 1978/79 was 495 million dollars. External debt rose to 2.1 billion dollars and there has been an accumulation of arrears in meeting the Bank of Sudan's foreign commitments, compounded by a rising debt service to exports ratio and a shortening in the average maturity of loans.

Sudan's balance of payments problems are the result of a number of factors, only some of which are related to the increases in world energy prices. Nevertheless, because world energy prices are so high, energy now constitutes a sizable portion of Sudan's

import bill. Increasing the efficiency with which petroleum is used or increasing domestic energy supply can significantly alter foreign exchange constraints on economic growth and investment.

The bulk of investment and other development resources over the past decade have gone into mechanized agricultural projects which were conceived and initiated in a period of relative energy abundance. These projects have tended to be energy-intensive, as well as being heavily dependent on all forms of imports. Several of these projects - such as the 500 million dollar Kenana Sugar Scheme - are just beginning to come on stream. On the one hand, this should increase exports and earn foreign exchange; on the other hand, energy consumption and imports will be significantly heightened in the process. For any existing project, such a tradeoff is clearly worthwhile to the extent that export receipts exceed energy and other import requirements. However, a long-term policy better adapted to a world of energy scarcity may be to seek to improve small farmer productivity and marketing, using more labor-intensive methods of production and distribution, while fully exploiting the export potential of existing projects. These are, in fact, the broad policy outlines for the period 1980-1990 that have been sketched by the Ministry of Planning. This example is representative of the necessity of incorporating energy concerns into national sectoral economic planning; and developing the data base and analytical methods to do so.

2. Effects of Shortages on Prices and Production

Fuel shortages during peak plowing and planting seasons have restricted agricultural production by limiting the number of acres which can be cultivated during the appropriate season. This effect is, of

course, especially important for rainfed areas, which constitute 13.5 million of the 17 million feddans under cultivation. The 17 million feddans, in turn, are only a small portion of the 200 million feddans of cultivable land in Sudan. Fuel scarcity has amplified the problems of an already inefficient agricultural transportation system, reducing the ability to bring products to collection points, raising the cost of doing so, and aggravating delays in transport from railhead and other collection points to markets.

Irrigated lands depend upon liquid fuels for water supply. Virtually all mechanical pumping relies on diesel fuel. Fuel shortages have therefore had a sizable impact on both the price of output and the productivity on irrigated lands. The 3.5 million irrigated feddans in Sudan include some of the most productive agricultural land, and account for a much higher than proportional share of cash-crops and exports.

Energy shortages have adversely affected industry and commerce in a variety of ways. In addition to the direct impact of higher prices, the unavailability of gasoline makes transport of parts and materials more unreliable than it normally is. A direct effect of this is a lowering of productivity and capacity utilization, while indirect effects include the high costs of maintaining large inventories as a protection against supply disruptions. Industry has been even more severely disrupted by shortages and inconsistency in electricity supply. Costs can be measured in terms of lost output, lowered productivity and the incremental expense of maintaining private standby power generation capacity. The recent increase in privately owned generation capacity also tends to increase the dependence on scarce oil supplies.

3. Rural Energy Needs

Energy needs in rural areas for both domestic and agricultural uses center around a different set of issues than do the needs of the modern, fossil fuel-dependent sectors. With the exception of water pumping, rural needs depend upon human and animal labor and upon wood. Eighty percent of total national household fuel consumption, and virtually all rural household fuel consumed is firewood. As the wood needs of the population have come to outstrip the natural regeneration capacity of the environment, the effects have been twofold: greater distances must be travelled to obtain the needed firewood; this in turn is a consequence of environmental damage in the form of deforestation around certain population centers, and an actual advancing of the desert in areas of marginal vegetation (in the arid Northern half).

One central point needs to be underscored when addressing the overall energy picture in the Sudan:

> In the short and medium trun, the energy needs and problems of traditional wood-dependent rural areas are extremely different from thoseof the modern petroleum-dependent sectors. Solution of Sudan's foreign exchange-based "petroleum energy crisis" will not - in this time frame - have any significant bearing on the environmentally-based "wood energy crisis" of rural areas, and vice versa.

In the long run, the problems of the two sectors are much more interdependent, as the range of options for fuel substitution increases. Even in the short term, however, there are obviously interactions between the traditional and modern sectors at a number of levels: foreign exchange shortage limits development

investment for traditional as well as modern activities; relative prices affect substitution between charcoal and petroleum-based fuels amongst the urban poor and so on. Nevertheless, the two "crisis" depend upon different imperatives, affect different variables, may have different degrees of urgency and will require entirely different kinds of solutions. In particular, addressing rural energy needs appears to be part of a process of overall rural development, and involves increasing the energy options of rural populations.

4. Energy for Economic and Industrial Development

The short-term need to limit and even lower the consumption of imported fuels should be viewed in the context of increasing the efficiency with which these fuels are used. Furthermore, that necessity should not be allowed to obscure the long-term importance of making increased energy inputs available for economic development. There appear to be five major components to Sudan's long-term economic strategy:

- to encourage and support small-owner agricultural production;
- to fully and efficiently develop the mechanized farming schemes for cash crops and exports;
- to promote growth of the industrial sector, particularly in the areas of agricultural processing and export goods;
- to expand transport and infrastructure;
- to develop mineral and other natural resources.

Of these five components, four are necessarily energy-intensive, and realization of these objectives must be linked to a long-term energy strategy. Because the

shortage of imported energy is inseparable from balance of payments problems, any energy strategy must also be integrated into a larger foreign exchange strategy as well.

Another element of an energy strategy for economic growth will be a program for energy resource development - both in terms of conventional resources such as petroleum and hydropower, but also in terms of such renewable resources as biomass, sugar derivatives, wind and solar power and geothermal energy. Finally, improvements in energy efficiency can, in the long-run, make significant contributions to reducing energy constraints on economic and industrial growth.

5. Electricity Supply

The inadequacy of electricity supplies has been one of the most uniformly acute constraints on industrial sector productivity and growth. Of existing installed electricity capacity, over 60% is supplied by hydropower (at the Roseris Dam). Currently installed capacity is inadequate. Electricity supply is subject to fluctuations in voltage which can damage machinery, and to very frequent power disruptions, leading to enormous losses of production time in industry. Inadequate generation capacity has been further complicated by management difficulties.

In the new Three Year Investment Plan announced in 1979, development of power and transport infrastructure are the two highest priorities. The "Power III" project, now underway aims to double electricity capacity by 1984-85.

Electricity supply problems have contributed directly to a further worsening of energy supply/demand balances by leading to the increased use of diesel generators for industries and institutions which cannot

afford the unreliability of the central power supplies. Electricity bottlenecks have been a major impediment to foreign investment and industrial expansion, such that present electricity use reflects a supply-constrained demand.

The use of hydropower for electrical energy also has potential in small scale, decentralized applications, particularly in the Southern Region, where water resources are more abundant.

6. Transport and Energy

Major centers of population and economic activity are widely dispersed over the million square miles of Sudan's territory. Foreign trade - in terms of imported spare parts, raw materials and consumer goods, and exports of agricultural products - plays a central role in the economy. While Port Sudan serves as the principal point of both entry and departure for international shipments, most major producing and consuming areas are over one thousand kilometers away.

The inability of the railroad system to meet transport requirements has had a particularly deleterious effect on energy consumption. Over the past decade, while rail freight levels have remained virtually unchanged, traffic by road has increased by nearly 200%. The recently completed paved road between Khartoum and Port Sudan, while vastly improving transport efficiency, is expected to further aggravate the energy-intensity of transportation. As an indication of the relative energy efficiencies of the two modes, average railroad efficiency is between 270 to 470 ton-miles per gallon, vs. only 70 to 125 ton-miles per gallon by truck.

Limitations of gasoline have hampered freight transport, especially to and from the more remote

areas of the country. In many such areas, transportation bottlenecks have impeded movement of perishable agricultural products to market, thereby affecting income directly.

Conversely, the inadequacy of the transport system as a whole has frequently affected the regional availability of fuel supplies, once again, particularly for remote agricultural areas. As noted earlier, an important implication of this bottleneck has been fuel scarcity at peak cultivation periods, with adverse consequences for agricultural output in rainfed areas.

These energy problems, issues and opportunities constitute the rationale and the central concerns for a national energy assessment. As described below, that assessment must also be concerned with the institutional structure within which energy plans are formulated and carried out. The structure of an assessment to address these concerns is discussed in the next section.

III. PROJECT ELEMENTS

A. Supply - Demand Analysis

The first step in the assessment will be to construct a consistent set of information on energy demand and supply considering all uses and all fuels. The analysis should encompass the current situation and projections of future demand - supply balance. This entails several steps:

1. Data Collection on Energy Use

Available secondary sources of information on energy consumption will be evaluated to determine the need for surveys of energy consumption patterns. It is likely that a survey will be required of household energy use, including wood and charcoal in rural and urban regions. In the early stages of the project, a pilot survey in one province would

be informative in itself and would provide the basis for a national effort. The results of a pilot survey in one region would not be representative of energy use in the country as a whole. However, the experience gained in that survey could then be applied to other provinces through several later surveys.

In the industrial sector, the use of centralized sources of information (e.g. fuel distributors) will be supplemented by plant visits and interviews in the most energy-intensive sub-sectors. For transportation, consumption of fuels will be analyzed for each mode. The commercial and government sectors will be similarly analyzed.

If possible, data will be collected on a province-by-province basis, although that may be possible only for aggregate sales data. The survey and data collection efforts in each sector will aim at the following kinds of information:

i) current activity levels: e.g. hours of cooking, tons of cotton produced, ton-km of freight transport;

ii) the devices and fuels used to perform those activities: e.g. amount of wood, charcoal or gas for cooking, amount of electricity or diesel fuel for irrigation pumping;

iii) expected future levels of activity and fuel use;

iv) possibilities of increased efficiency of fuel use and substitution of renewable fuels.

2. Demand Projections

National economic development plans and prospects will be reviewed to establish the economic context for future energy demands. Based on this and the

demand analysis described above, a consistent set of projections of activity levels (output, etc.) and fuel requirements will be projected based on current plans and policies. The projections will extend to 2000, with at least one intermediate year (e.g. 1990).

3. Resource Evaluation

In a corresponding way, estimates will be made of the future availability of energy resources under current policies and trends. These will include oil and gas, refined products, hydropower, wood, charcoal, insolation and the wind regime plus geothermal potential.

4. Supply-Demand Balances

For two or three future years a projected energy demand - supply balance will be created from the elements described above. From these can be derived oil import (and foreign exchange) requirements, wood and charcoal needs, capital and infrastructure costs, etc.

B. Strategy Analyses

In this section of the assessment various energy strategies will be examined that address the energy issues identified in Section II above. These strategies will be aimed at increasing the reliability of energy supply, reducing the balance of payments burden of energy supply, increasing the energy self-sufficiency of the country and, in general, satisfying the energy requirements of economic and social development in the most cost-effective manner possible. Strategies will be examined in the following specific areas, employing as a reference the supply - demand projection prepared in Element A above. For each strategy, impacts on energy demand (traditional and commercial), total costs of energy, self-sufficiency, etc. will be evaluated.

1. Energy from Biomass

Various ways of producing energy from biomass will be examined. These will include, for example,

- direct combustion of agricultural waste for electricity production;
- conversion of agricultural waste to liquid or gaseous fuels for use in electricity generation or as supplemental fuel (e.g. ethyl alcohol from molasses as an additive to motor gasoline);
- wood production in managed forests for direct combustion or conversion to charcoal or methanol.

2. Alternative Energy Use in Agriculture

- solar and wind irrigation pumps;
- methanol or ethanol based tractor fuels.

3. Energy for Rural Households and Small Scale Industry

- solar and wind pumps for drinking water;
- biogas systems for cooking;
- increased efficiency in charcoal production;
- decentralized electricity generation from e.g. mini-hydropower,
- community woodlots
- alternative cooking devices

4. Energy for Transportation

- energy implications of alternative transportation modes especially bus or car; railroad or truck; river and canal freight transport vs truck and rail;
- alternative transport of energy products; pipeline vs barge vs truck vs rail.

5. Industrial Energy Requirements

- Increased efficiency of energy use;
- substitution of renewable resources: e.g. solar process heat and biomass - derived fuels.

6. Urban Energy Requirements

- households: increased efficiency and use of renewable fuels;
- commerce and government.

7. Electricity Supply

- alternative fuels (e.g. wood)and hydro-power;
- centralized vs decentralized production.

8. Pricing

An analysis will be made of the current pricing situation and particularly the effects of conventional energy pricing on the competetiveness of new energy technologies.

It is recognized that a number of studies have been carried out or are under way in these various areas so that the level of effort required in this assessment will vary considerably between areas. An important requirement will be that the strategy analyses be consistent and comparable and that they together constitute as complete a view of overall national energy strategies as possible.

C. Policy Analysis

There are two elements to this phase of the assessment. The first entails establishing priorities among the various strategies analyzed in the previous sub-task. This will involve the application of quantitative criteria such as cost and energy savings and the consideration of institutional and other criteria which determine the feasiblity of various options and approaches. The analysis must be approached in a collaborative fashion between the U.S. team, their Ministry counterparts and others in the Government who are concerned with the implementation of various strategies.

The second element of this task is the definition of programs or project areas required to implement those strategies found to have the highest priorities. It will not be possible to produce detailed project designs, but only to identify the kinds of projects that are the most important to pursue. Some of the project areas may be appropriate for support by USAID. Others may entail major capital investment and require support from private,

national or international lending institutions. Others may be able to be implemented directly by the Ministry.

The kind of integrated energy analysis outlined here should be pursued to the point of defining project areas. Beyond that point the further definition of specific projects and programs can proceed somewhat independently from considerations of the total national energy picture. The integrated analysis, however, provides the necessary context and justification both for strategies and for programmatic areas.

D. Institutional Development

In this project the support to the further development of the energy section of the Ministry of Energy and Mining has two aspects. The first is the professional development of energy analysts in the Ministry. This will be accomplished by the active participation of Ministry personnel in all phases of the assessment. In order to accomplish this, Ministry personnel should be the principal agents in carrying out the assessment, with assistance and guidance provided by their U.S. colleagues.

The second aspect of institutional development will be assistance in the development of the planned National Energy Administration. The President's Decree Number 426 of May 21, 1980 established the structure of the National Energy Administration as shown in Exhibit I. This assessment will be perfromed within the framework of the Planning and Research Section of that Administration. Technical Staff from the United States Team will work closely with counterparts within that Section, and the early stages of the assessment will be of great utility in structuring the Section to meet the Ministry's planning and implementation responsibilities.

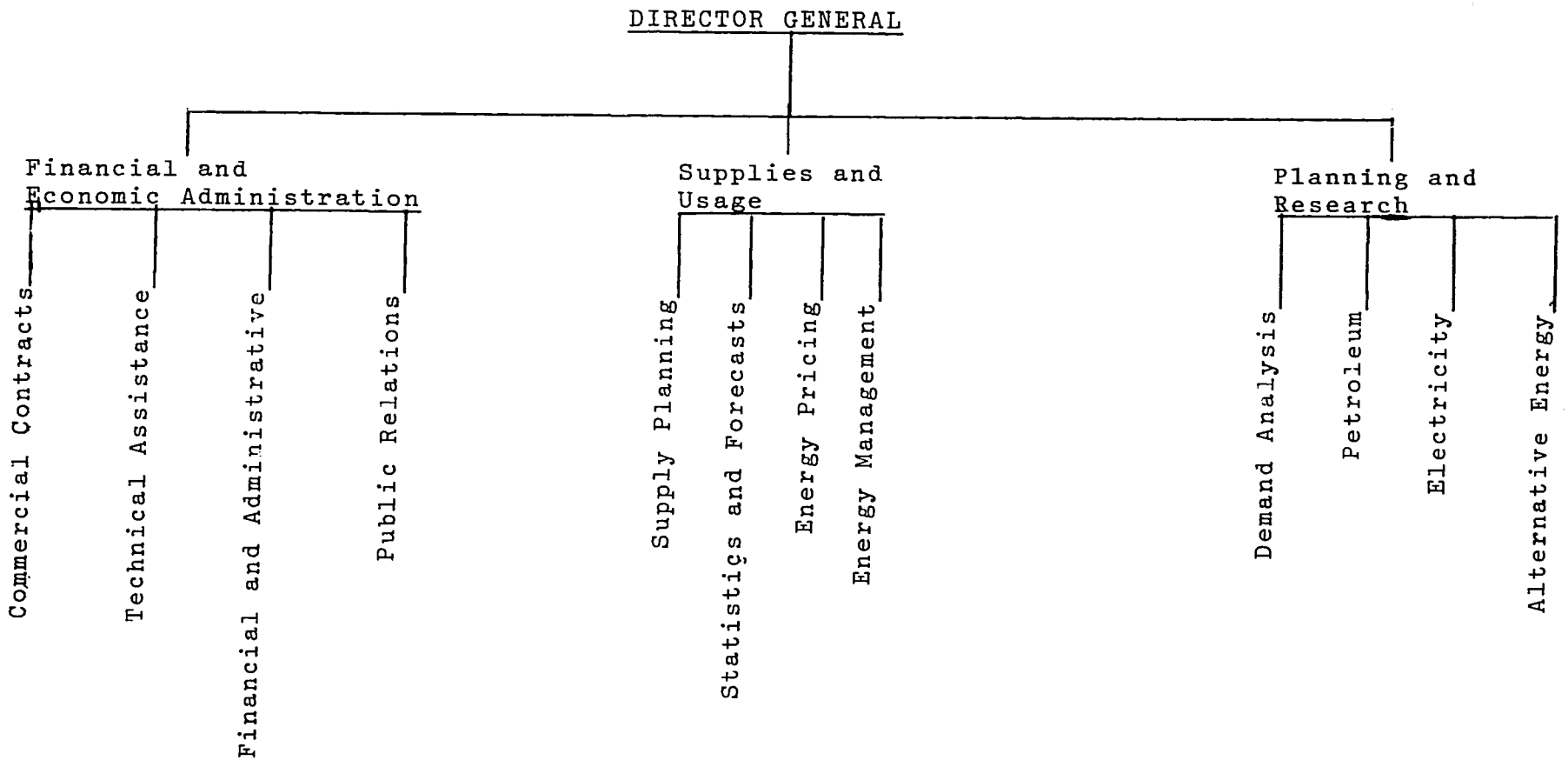
IV. PROJECT IMPLEMENTATION

A. Government Participation

As discussed above this project will accomplish its

EXHIBIT I

NATIONAL ADMINISTRATION FOR ENERGY



goals only if it is carried out as a close collaboration between members of the U.S. team and analysts and policy-makers in the Ministry of Energy and Mining. If at all possible, office space should be provided where U.S. and Sudanese analysts can work together. The Sudanese counterpart group should be constituted roughly along the following lines:

2-3 analysts essentially full time to participate in demand analysis, supply-demand integration strategy analysis and policy analysis.

2 supporting junior analysts to carry out computational aspects of the analysis.

specialists to act as counterparts to consultants in the following areas;

- industrial energy use;
- transportation;
- rural development and rural households;
- agriculture and forestry.

These specialists may well come from the Ministries responsible for these areas. In addition, counterparts in the following technical areas should be identified:

- solar energy and wind power;
- biomass;
- hydropower;
- electric system.

In all of these apreas the specialized analysis will be carried out over a period of 1 - 2 months.

The overall assessment, although centered in the Ministry of Energy and Mining, will require the active cooperation of many other Ministries and Corporations (Planning, Finance, Transportation, Agriculture, Electricity, Sugar, River Transport, to name a few). It would be highly desirable to constitute an overview committee for the assessment with representation from the most critical agencies. The committee would have three functions:

1. To assure the required participation of personnel of the agencies and access to pertinent information.

2. To assure that information and analyses generated in the assessments find their way to appropriate points in other Ministires.

3. To provide guidance on overall policy issues so that conclusions and recommendations from the assessment will find acceptance and implementation.

B. Level of Effort and Schedule

The specific manpower requirements for the study will depend somewhat on the individuals who will be chosen to carry out the assessment. However, it is estimated that a level of effort of 60-65 person-months will be required of the U.S. team over a period of 18 months. Included in this number will be two analysts who would be resident in the Sudan for a large proportion of the 18 month period. They would be responsible for project coordination, professional development, demand analysis, integrative analysis and policy analysis. In addition, visits of 4 - 6 weeks each would be required of specialists in the following areas (if not covered by the long term staff):

- Transportation demand and options;
- Industrial demand, efficiency and alternative fuel use;
- Agricultural production and energy alternatives;
- Rural energy surveys and options;
- Urban energy surveys and options;
- Solar and wind energy;
- Biomass use and conversion;
- Large and particularly small scale hydropower;
- Electric systems;
- Fuelwood uses and conservation
- Energy information systems.

In addition, it will be useful to include 2 - 3 months of time at the early and later stages of the assessment of a senior energy policy analyst.

Although the assessment will occur over 18 months, during that time there will be opportunities to identify specific areas of activity which might begin to have a

more immediate impact on energy imports and the overall foreign exchange situation.

AID will support the cost of some office equipment, a project secretary, and travel of U.S. team members. The Government of Sudan will be expected to provide all expenses of the Sudanese participants including the local costs of in-country surveys that are required.

A preliminary schedule of the project would be as follows:

Month	
1	Preparation and planning in U.S.
2	Arrival in Sudan of long term U.S. team members. Organization and preparation for work of specialists.
3-8	Demand analysis and resource analysis by long term personnel; design and implementation of survey.
8-11	Strategy analysis by specialists and long term personnel.
10-15	Policy analysis.
15,16	Final report preparation.
16, end	Draft report available for review within Sudan.
18	Revision of final report.

For each of the major tasks identified in Section III above, a report will be prepared for internal use and as a basis for preparation of the final report. In addition, a report will be prepared on the design of the Department of Energy within the Ministry. The timing of that report will depend on the requirements of the Ministry.

TA . 1

BASIC DATA ON SUDAN

Area:	2,505,813 square kilometres
Population:	17.76 (1975)
Growth Rate:	2.8%
Infant Mortality:	121 per 1,000 live births
Life Expectancy at Birth:	51 years (1972)
Gross National Product:	$4,338.4 million
GNP per Capita:	$249

Value Added by Sector:

Sector	Percentage
Agriculture	44.3
Industry	14.4
Services	41.3
	100.0

TABLE 2

BASIC DATA ON SUDAN

(CONTINUED)

Major Exports (LS Millions - 1978)

Cotton	103.0
Gum Arabic	12.3
Groundnuts	27.9
Sesame	12.3
Livestock	5.4
Dura	3.0
Other	21.0
Total	191.9

Production of Major Crops (MT)

Cotton	607,000
Groundnuts	839,000
Sesame	242,000
Dura	1,900,000
Millet	400,000
Sugar Cane	1,200,000

Major Imports (LS Millions - 1978)

Food, drink, Tobacco	61.6
Raw Materials (incl. petro)	50.8
Chemicals	41.6
Textiles	37.8
Machinery + Transport Equipment	169.4
Other	88.3
Total	449.5

Livestock Population

Cattle	15 million
Sheep	14 million
Goats	11 million
Camels	3 million

TABLE 3

SUDAN ENERGY SUPPLY AND DEMAND BALANCE SHEET

(10^3 Tons of Oil Equivalent)

Energy Demand Category	Total Energy on Input Basis	Percent of Total	Percent of Coverage of Demand by Various Sources				
			Petroleum Products	Hydro	Firewood	Charcoal	Bagasse
Direct Heat	31,081	75	4.8		79.3	15.7	0.2
Industrial	6,792	16.4	14.6		77.5	7.3	0.6
Domestic	24,290	58.6	2		80	18	
Transport	7,015	17	100				
Road	4,402	10.7	100				
Railway	1,782	4.3	100				
Aircraft	591	1.4	100				
Rivercraft	240	0.6	100				
Tractor, Pumping, Eng., Construction, Plant	2,469	6	100				
Tractor & Ag. M/Cs	1,174	2.8	100				
Pumping	943	2.3	100				
Eng. & Constr.	360	0.9	100				
Electricity Generation	815	2	375	62.5			
TOTAL	41,380	100	27.35	1.25	59.5	11.8	0.1