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DEMOCRATIC REPUBLIC OF SUDAN

MINISTRY OF ENERGY AND MINING

NATIONAL ENERGY ADMINISTRATION

THE NATIONAL ENERGY PLAN

1985-2000

Prepared by the

National Energy Plan Committee

1985

P.O. BOX 2649 KHARTOUM SUDAN

Excerpt from speech delivered at the Peoples' Assembly during the Second Presidential Inauguration, May 25, 1977.

Ambitious development of energy besides depending on the capability of the Sudanese people and their determination also depends on financial resources, some of which we have and some which require effort to obtain. By this I mean the ideal development of our hydro and solar resources, especially, since the world is living through the beginnings of an energy resources crisis. We have to take the initiative through planning and implementation and to consider all the possibilities including whether or not petroleum is available in our land. And whether its discovery and utilization is delayed. On this path, and according to studies which I have assigned to our specialized scientists and with help from international expertise, I am about to make fundamental decisions to develop new energy resources in Sudan and to realize the best development of nonconventional energy resources available in our country.

GAAFAR MOHAMED NIMEIRY

FORWARD

Presented herein is the the National Energy Plan, 1985-2000. Work on this Plan commenced in May 1983 following a decree from the Minister of Energy and Mining (Decree No. 5, Year 1983).

Contributions to the development of the Plan were made by six organizations from within the Ministry and eight other governmental bodies. In addition, 11 foreign organizations and companies working in the field of energy provided their expertise and assistance. In total 110 Sudanese researchers and 19 foreign experts (see Appendix 2) attended or contributed to the 190 meetings held during the development of the Plan. Our thanks to them all.

The Plan is the result of 20 months of effort undertaken in two phases. Five committees worked on the first phase which was concluded in December 1983:

1. Demand Forecast Committee.
2. Energy Supply & Resources Committee.
3. Debottlenecking Committee.
4. Energy Conservation & Demand Management Committee.
5. Plan Implementation Committee.

The second phase began in January 1984 with the following Committees:

1. Techno-Economic Options Committee

   a. Petroleum Technical Subcommittee

   b. Electricity Technical Subcommittee

   c. Renewable Energy Technical Subcommittee

2. Debottlenecking Committee

   a. Petroleum Subcommittee

   b. Electricity Subcommittee

   c. Dams Subcommittee

3. Plan Implementation Committee

4. Strategies and Objectives Committee

5. Chairman's Committee

6. Final Report Committee

The final Plan reports are:

1. Plan Executive Summary summarizing the main report.

2. The Main Report with Sectoral Plans: Petroleum, Electricity, Forestry and New and Renewable Energies.

3. Reports from each subcommittee detailing conclusions and analyses.

These reports define strategies and objectives, policies, conservation and debottlenecking programs, investment projects demand forecasts and available resources. The reports also for the first time identify possibilities & programs to utilize renewable & new energy resources.

Total investment requirements for 1985-2000 are:

Electricity	$ 3,832	Million
Petroleum	$ 815	"
New & Renewable Energies	$ 868	"

Total	$ 5,515	"

The National Energy Plan Committee and the National Energy Administration hope that this effort will provide the impetus for accomplishment and change.

Chairman of the National
Energy Plan Committee
Dr. John Gindi

Director General
NEA
Dr. Abdel Rahman Shulli

MINISTERIAL DECREE NO. 5, 1983

FOR THE NATIONAL ENERGY PLAN

In accordance with the Ministry of Energy and Mining's commitment to the Peoples' Assembly to prepare a comprehensive National Energy Plan in a short time to cover the period up to 1990, and after to the year 2000, I decide the following:

1. Committee Formulation:

Form a committee under the supervision of the Undersecretary of the Ministery of Energy and Mining and chaired by the Director General of the National Energy Administration with heads of planning units in the energy systems as members besides a number of consultants appointed by the Minister of Energy and Mining.

I have directed the consultancy bodies working in this field and Chevron Co. to help the committee as consultants.

2. Duties of the Committee:

Based on the progress of the Sudanese economy, the committee should:

a. Determine the actual demand for energy, superseding in doing so the historical data which reflect the continuous shortage in energy supply and taking into account the effect of urbanization on switching to different forms of energy and the effect of higher living standards.

b. The committee is to specify the resources available and to evaluate them economically with the aim of self-sufficiency in the field of energy, including new and renewable energies.

c. The committee is to make use of the efforts of other organizations in formulating an investment program for electricity, petroleum, new energies and conservation and a national plan for manpower development in the field of energy.

d. The investment program is to be presented as national plans for the regions.

e. The Plan is to recommend the participation of the Private Sector in energy projects and decide on the technological projects which support the energy program and on the pricing policy.

f. The committee should decide all other studies necessary to finalize the National Energy Plan.

3. Authority of the Committee:

As the job assigned to the committee is considered strategic, important and urgent, I hereby confer the following authority on the committee after discussion with the Committee Supervisor, the Undersecretary:

a. The committee is to make use of all documents, information and national officials in the ministery organizations and the companies working in the field of energy.

b. Set up subcommittees to undertake studies decided on by the committee.

c. Make use of computers and technical equipment available in the ministry and organization and research systems to help complete its work.

4. Facilities for the Committee:

The committee is to decide on an urgent budget for its work and submit it to the Supervisor of the committee to raise it from contributions from the Ministry's organizations and corporations.

5. Monitoring the Committee's Work:

The committee is to submit a monthly report to the committee Supervisor outlining the work, the achievements, and the problems encountered and the additional tasks to be performed.

Issued under my signature

on Thursday, 21st of April, 1983

Dr. Sharif El Tuhami

Minister of Energy and Mining

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GLOSSARY

BNG = Blue Nile Grid

BOS = Bank of Sudan

ERC = Energy Research Council

GDP = Gross Domestic Product

GMRD= Geological and Mineral Resources Department

GPC = General Petroleum Corporation

LS = Sudanese Pounds

MEM = Ministry of Energy and Mining

MEP = Ministry of Finance and Economic Planning

MOA = Ministry of Agriculture

NCR = National Council for Research

NEA = National Energy Administration

NEC = National Electricity Corporation

PSR = Port Sudan Refinery

pt. = Piastre

RERI= Renewable Energy Research Institute

TOE = Tons of Oil Equivalent

TVC = Technical Vocational Centers

NOTE

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ALL MONETARY VALUES IN THIS REPORT ARE EXPRESSED AT THE 1984 OFFICIAL EXCHANGE RATE OF 1.3 LS = $1.00

CHAPTER I

THE ENERGY SITUATION: NEEDS EXCEED SUPPLY

A. PROBLEMS

For the past five years consumers in the Sudan have suffered as the supply of energy has not met their needs and wants. This shortage has disrupted the lives of most people, forced up the cost of living and caused major losses to the economy. The situation has deteriorated recently and forecasts indicate that, if no changes are made, conditions will continue to worsen. The problem that must be addressed and its consequences can be summed up as follows:

ENERGY NEEDS EXCEED SUPPLY

Petroleum	--	**Permanent Allocation**
Electricity	--	**Regular Load Shedding**
Wood/Charcoal	--	**Shrinking Forests**

As a result of shortages, drivers of cars and lorries waste hours queueing for benzine and gasoil; businessmen see machines and workers idle when electricity is shut off; farmers watch crops dry up when there is no electricity or gasoil for irrigation pumps; consumers' electrical appliances are damaged by erratic electricity; rural poor spend more and more time looking for wood; and urban dwellers spend more and more of their income on buying charcoal.

The following three charts (Figures 1-1 to 1-3) show these problems quantitatively.

1. The first, "Continuing Oil Shortage," shows that demand for oil is about 25% higher than actual supply, and that this shortage has been growing. Demand has been reduced to the level of available supplies through government allocation of the shortage among different consumers and the different regions.

2. The second, "Blue Nile Grid Demand and Supply," shows the relationship between electricity generation, consumption, losses and "unmet demand." The "unmet demand," basically the gap between supply and demand, has been covered by load shedding, self-generation, and holding back expansion of services to new consumers.

3. The third, "Wood Fuel Inventory and Prices " shows how rapidly forests in the Khartoum, Central and Eastern Regions are being cut down. As a result, charcoal prices have risen so rapidly that todey they are over seven times the price of eight years ago. At today's level they are very costly for the majority of the urban population.

B. EFFECT OF PROBLEMS

Everybody in Sudan suffers hardship and losses as a result of energy shortages. Individuals are discomfited by the frequent electricity outages and waste hours waiting in lines for fuel. Productivity is reduced at the workplace as a result of such inconveniences. The economic effects, though, are

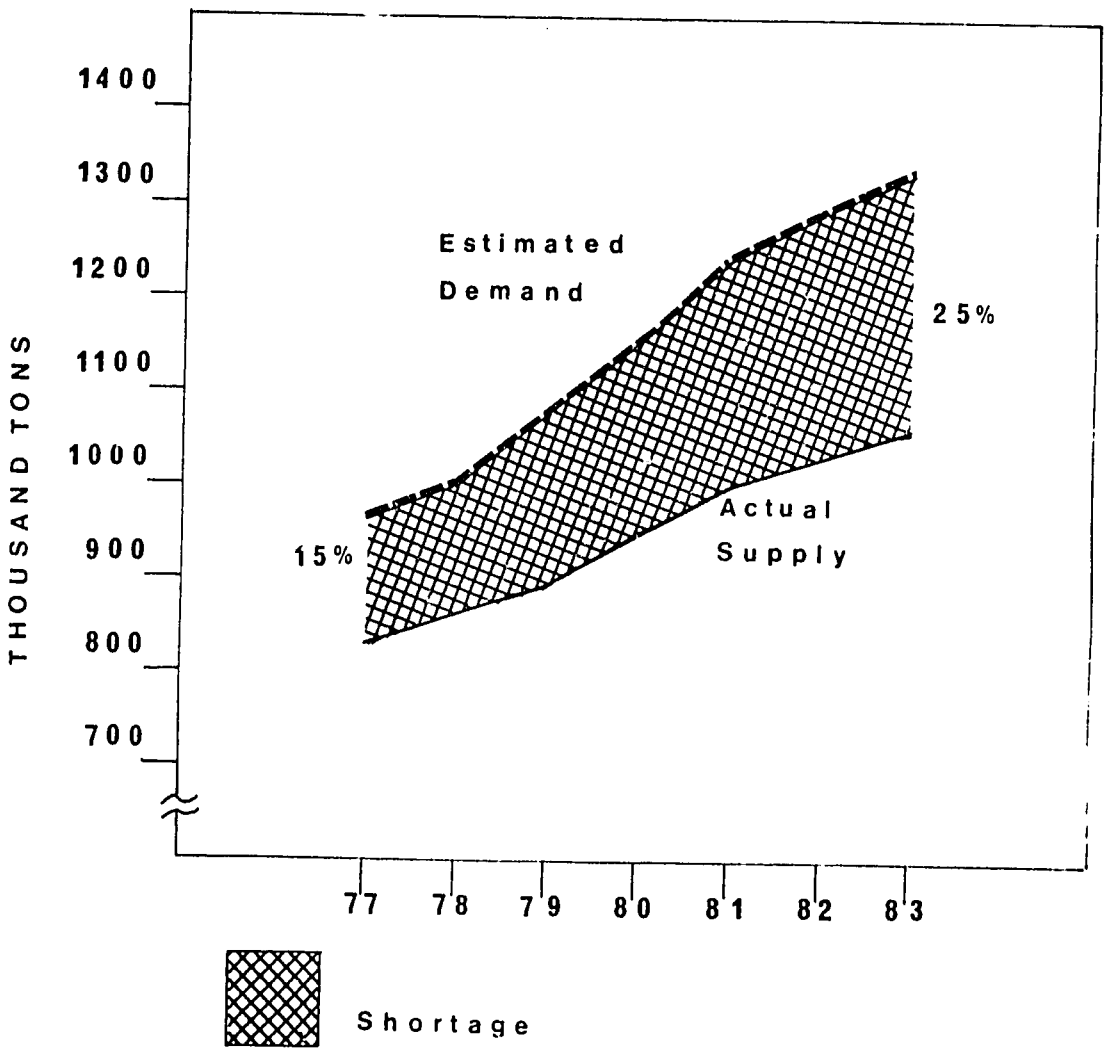
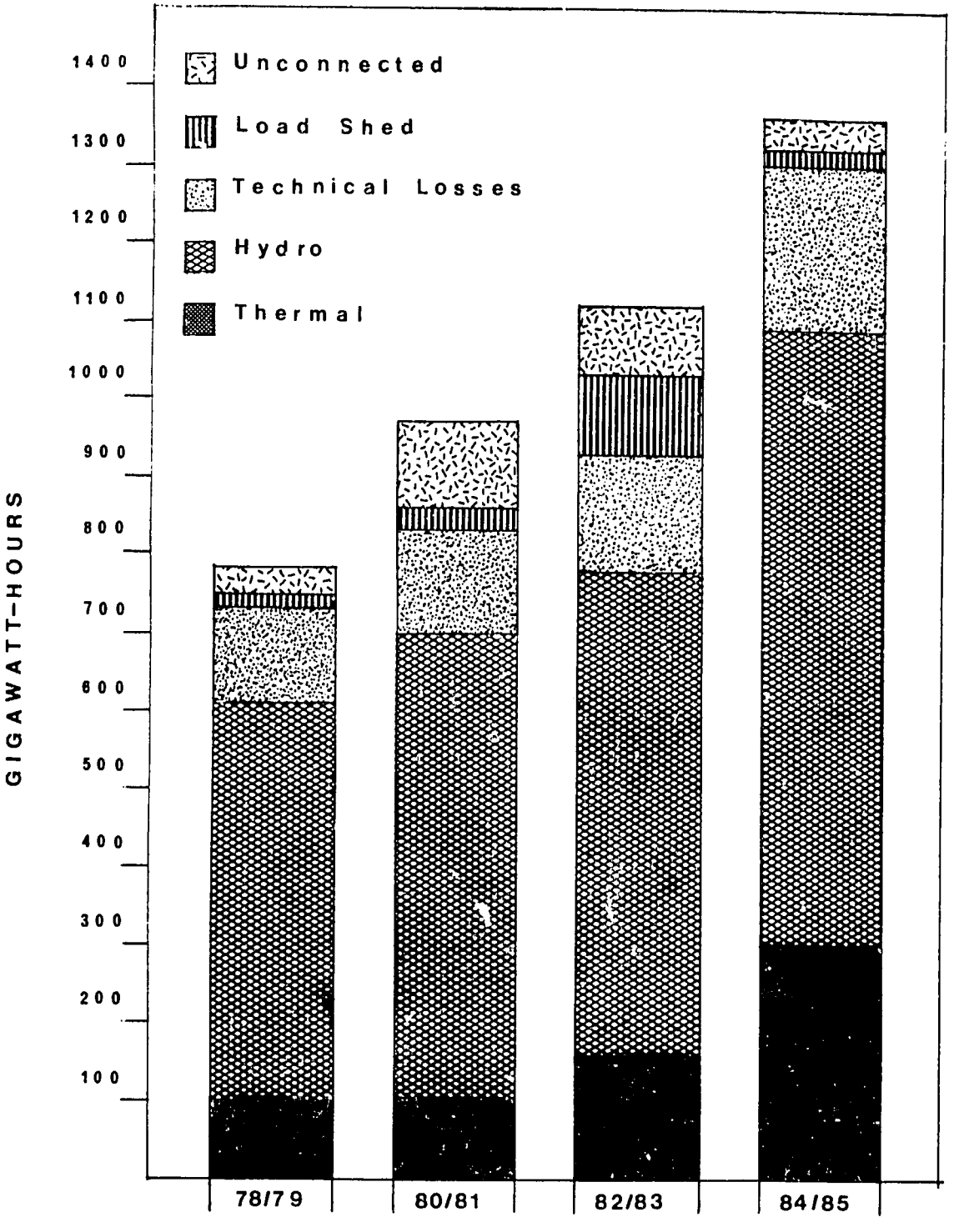


FIGURE 1-1. CONTINUING OIL SHORTAGE.

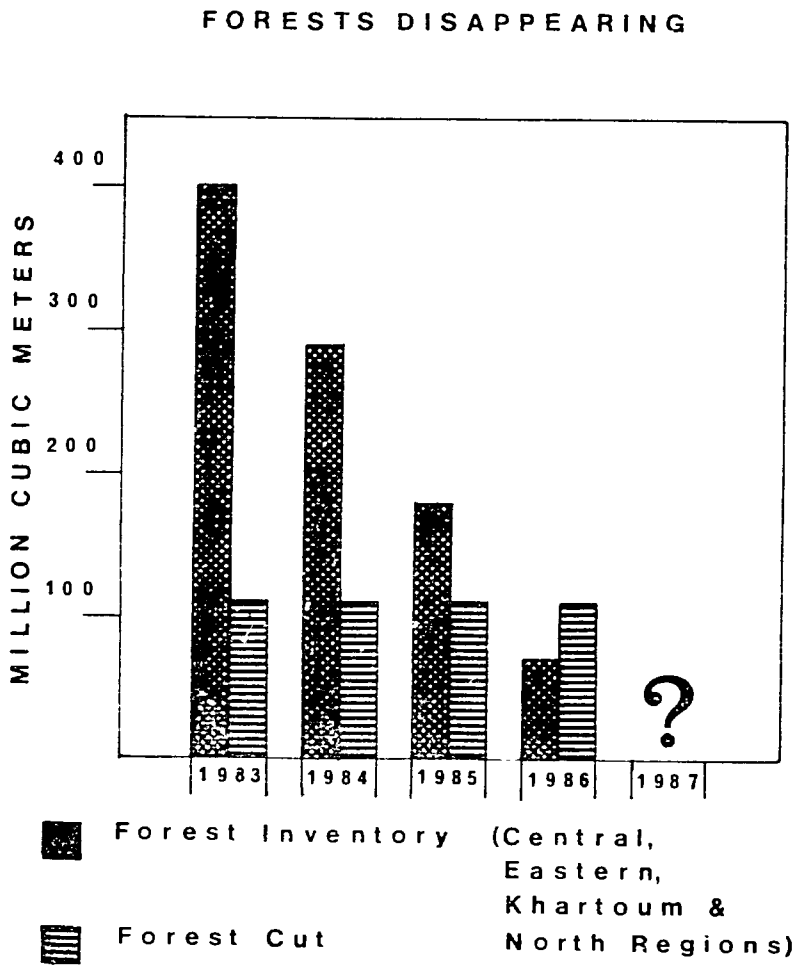


*Growing gap between expected and actual supply.

*Major improvement in 1984/1985.

*Losses exceed thermal output.

FIGURE 1-2. BLUE NILE GRID SUPPLY AND DEMAND.



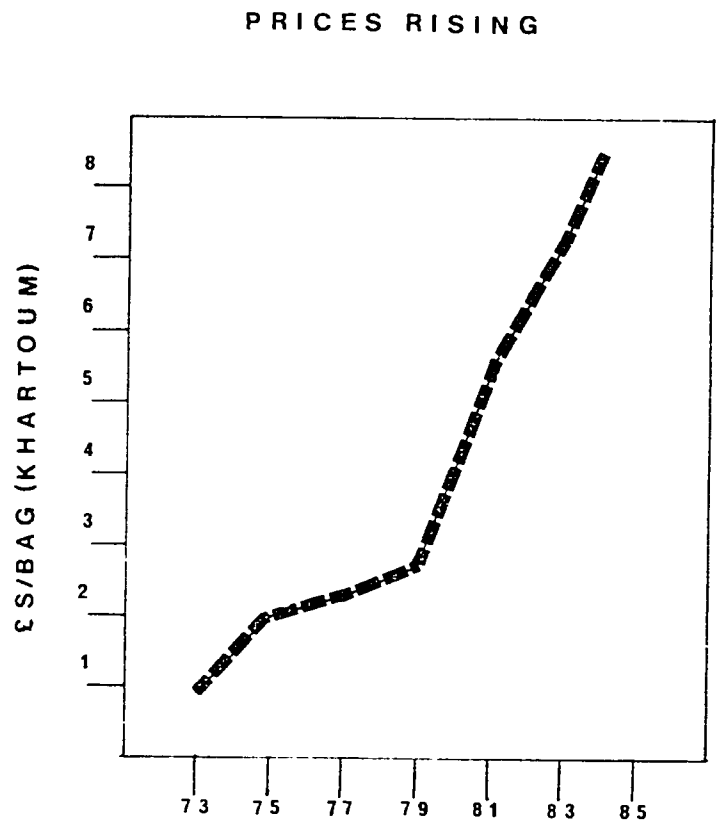


FIGURE 1-3. WOOD FUEL INVENTORY AND CHARCOAL PRICES.

concentrated in the industrial and agricultural sectors. Here almost all enterprises are plagued by a lack of energy leading to higher production costs, reduced output and wasted capital investment.

Costs result from 1) an absolute scarcity of energy and 2) unreliable supplies. The absolute scarcity limits economic growth: fewer feddans can be planted and irrigated; factory expansion plans must be deferred or scrapped; and new projects are cancelled or delayed. So the effect is that Sudan's GDP grows at a slower rate than would otherwise be the case with adequate energy.

The second type of shortage - unreliable supply - causes far greater losses to the economy. Huge costs are incurred when people undertake a project or production operation with the expectation of available power, only to find their operations plagued by unplanned electricity outages and/or unanticipated fuel shortages. Crops and inventory in process are spoiled and production costs increase due to high start-up expenses and the expense of securing back-up energy supplies. Additional costs are incurred as equipment is damaged by power surges and outages. Finally, losses result from the fact that capital invested, with the expectation of being fully utilized, lies idle. Expected profits cannot be realized but still the financing expense of the investment must be paid.

These losses were quantified for the smaller irrigated and mechanized farms for the Khartoum and Central Regions in 1983. Overall, Sudan suffered losses of 133 million LS for this portion

of the Agricultural Sector. Shortages ranged from 20-40% of required energy. The net LS losses by category are summarized in Table 1.1.

TABLE 1-1

AGRICULTURAL LOSSES DUE TO ENERGY SHORTAGES IN 1983

Type of Losses	Million LS
Crops not planted due to lack of energy	38
Crops lost due to interrupted power	70
Crops spoiled after harvest	15
Production cost increases	29
Capital damage, other	3
T O T A L	155
Cost of energy not supplied	22
Net cost	133

These huge losses in output resulted from the lack of fairly inexpensive energy inputs. In the irrigated electric pump schemes, the lost output was 3.54 LS per KWH while the cost of that KWH was only 13 pt. Similarly for mechenized farming, a loss of 18.5 LS was incurred for each unavailable gallon of gasoil costing 2.7 LS.

C. REASONS FOR PROBLEMS

Many factors are involved in the Sudan's energy crisis, but the main cause was the sudden dramatic escalation in oil prices ten years ago with a second major jump in 1980. Huge price rises not only made it more difficult to buy oil but also meant that scarce hard currency had to be diverted from other development purposes to buy oil, thereby slowing economic growth. These shortages of foreign exchange drastically reduced the country's capacity both to buy oil and to make important, badly needed investments in expanding the electricity system. The country did not respond to this critical situation early enough or drastically enough. Consequently:

> **The high dependence on imported oil continued and was even encouraged by subsidization of consumer prices.**

> **The importance of investment in the use and development of indigenous resources, such as hydro power, was largely ignored.**

The failure to respond to a critical situation which required fundamental reform reflects reluctance to change existing systems even when they have proved to be unsuitable in a new set of circumstances.

High oil prices and the foreign exchange crisis have effected all energy sectors. Each sector, though, has its own reasons for the problems being experienced today. These are summarized below in Table 1-2. A common thread runs throughout with certain factors such as inefficient uses of energy and increases in demand with no attempt to discourage excessive consumption found in all sectors.

TABLE 1-2

REASONS FOR PROBLEMS

PETROLEUM SECTOR

INSUFFICIENT INVESTMENT

* Foreign exchange shortages resulting in inadequate and unreliable supplies.

INEFFICIENT USE OF EXISTING SYSTEM

* Petroleum purchased on unfavorable terms.
* Logistics system poorly utilized as petroleum supply varies with foreign exchange availability.
* High demmurage charges incurred.

DEMAND INCREASE FOR ECONOMIC GROWTH

* Growth in agriculture, transportation, industry, consumer goods sectors.

CONSUMPTION ENCOURAGED

* Consumers lack incentive to conserve.
* Unrestricted imports of energy inefficient systems.
* Products priced below economic cost.
* Unreliability of river and rail has forced shift to trucking.
* Expansion of thermal power not hydro.
* Private transportation favored over public.

REASONS FOR PROBLEMS

ELECTRICITY SECTOR

INSUFFICIENT INVESTMENT

* Inadequate investment in generating capacity, particularly hydro.
* Electric Sector a low priority in national investment of scarce capital.

INEFFICIENT USE OF EXISTING SYSTEM

* Inadequate maintainance.
* Lack of spare parts.
* Large losses.
* Manpower brain drain.
* Delay in implementation of power projects.
* Depletion of hydro storage capacity.
* Wide annual and seasonal variations in hydro ability.

DEMAND INCREASE FOR ECONOMIC GROWTH

* Agriculture, industry.
* Population increase.

CONSUMPTION ENCOURAGED

* Low prices.
* Uncollected, unbilled consumption.
* Uncontrolled demand.
* Growth without priorities.

REASONS FOR PROBLEMS

WOOD FUELS SECTOR

INSUFFICIENT INVESTMENT

* Royalties for cutting inadequate for replacement.

INEFFICIENT USE OF EXISTING SYSTEM

* Inefficient conversion and end use technologies.
* No effective forestry land use management at national or regional levels.
* Trees from forests clear cut for agriculture are not used for fuel.
* Receding forests increase transportation costs.

DEMAND INCREASE FOR ECONOMIC GROWTH

* Population growth.
* Urbanization, resulting in higher demand for charcoal.

CONSUMPTION ENCOURAGED

* Lack of alternatives.

CHAPTER II

OUTLOOK: MORE PROBLEMS IF NO CHANGES MADE

A. APPROACH AND ASSUMPTIONS

The previous chapter established that current energy problems are serious and that they are partially a result of conditions beyond Sudan's control (price of oil) and partially a result of choices taken, or not taken, and decisions made, or not made, within the Sudan.

The future energy outlook will be shaped by where we are today and also by future events. Again, some of these events will be uncontrollable. But, we will also find that choices can be made, and decisions taken, that will affect the future. The challenge will be to make the right choices and decisions.

However, in order to rationally explore and evaluate future options, it is necessary to project the future outlook, for both supply and demand, of the major energies used by Sudan. This initial projection will be based on two sets of assumed bases: first, economic and physical events that affect energy, but are largely outside the control of the Energy Sector; and, second, strategies and policies that can be affected by the Energy Sector.

The first set of economic and physical assumptions have been designed to be reasonably optimistic, but not extremely so.

1. Economic and Physical Assumptions

a. GDP will grow 4%/year.

b. Population will grow 3%/year.

c. Each economic sector will grow according to government planning levels.

d. A three-year petroleum financing grant will start in early 1985 at $120 million/year.

e. Crude exports will begin late in 1987 at 50,000 barrels/day; volume will increase 10%/year, prices 3%/year.

f. Power III will be completed in early 1985.

The second set of strategy and policy assumptions are strictly a continuation of past and current ones. There is no judgment here whether they are good or bad, or right or wrong, but they are a necessary first step to evaluate the future consequences.

2. Strategy and Policy Assumptions

a. Low energy prices are continued with furnace oil and electricity subsidized.

b. Demand growth continues uncontrolled with no broad effort in place to discourage low priority or uneconomic use.

c. Continued limited emphasis on developing indigenous resources.

d. Power IV planned as primarily thermal (financing uncertain).

e. Shortages continue to be handled day to day by rationing (oil "allocation," electricity "scheduling").

Figures 2-1 and 2-2 summarize the growth in demand for the entire ecomomy using these assumptions. As can be seen, basic consumption of raw energy resources is expected to rise from 8 million TOE to 12 million TOE in 10 years. Finished energy delivered increases from 7 million to 9 million TOE. While electricity is the fastest growing sector, biomass continues to be the dominont energy input in both its raw and finished forms.

Projections will now be made for demand and supply for each Energy Sector. Subsequently, the demand and supply projections will be compared to see what problems are likely. The nature, size and consequences of these projected problems will then be assessed. In the second part of this chapter possibilities for change will be described and in Chapters III and IV changes will be recommended to improve the current outlook.

▲ Wood has dominant share.

▲ 85% from own resources.

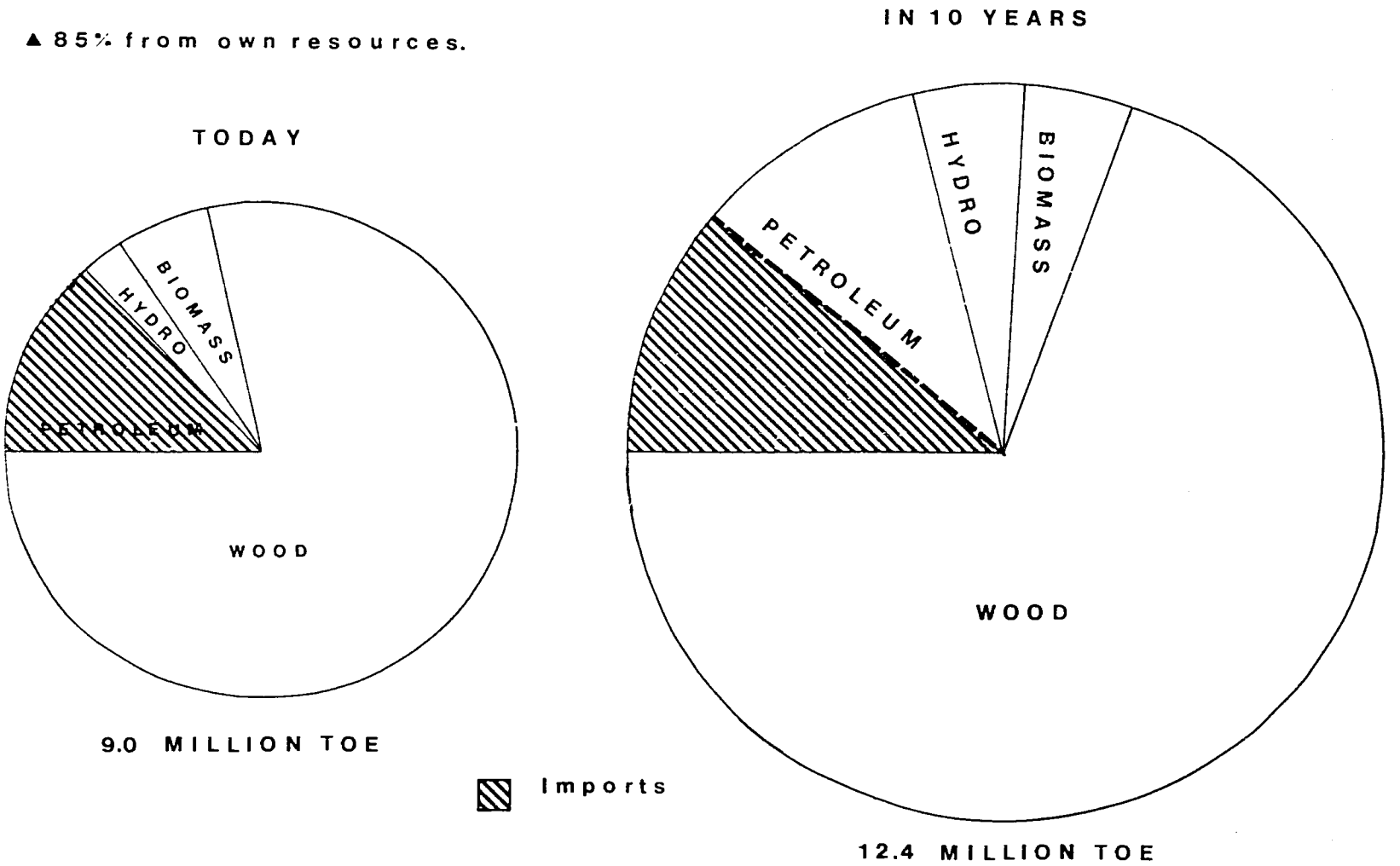


FIGURE 2-1. DEMAND FOR PRIMARY ENERGY.

▲Solid fuels dominate.

▲Electricity growing rapidly.

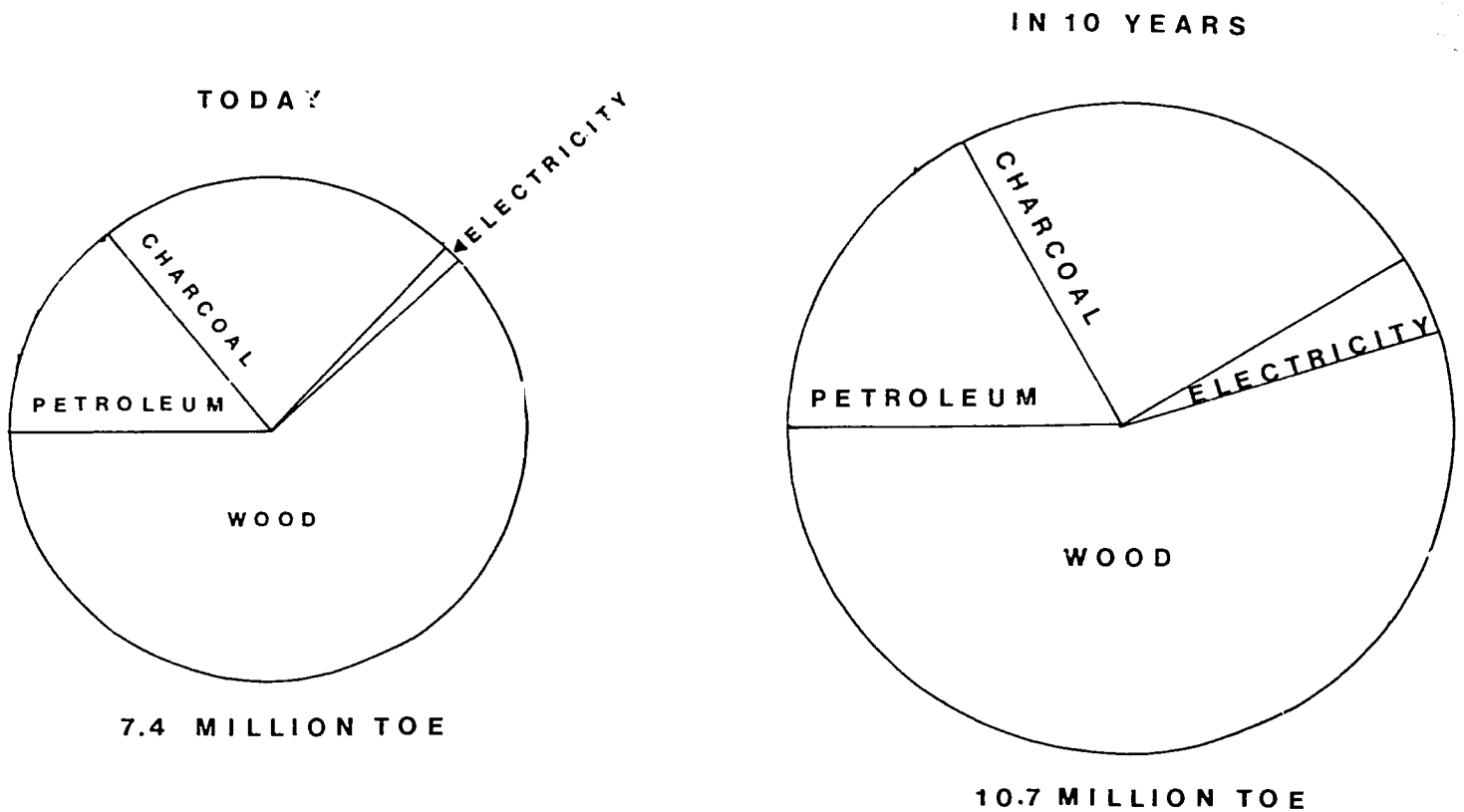


FIGURE 2-2. DEMAND FOR FINAL ENERGY.

B. PETROLEUM DEMAND AND SUPPLY

1. Demand

In late 1983 a detailed study was made of future demand, based on known government and private sector plans. The underlying assumption for planning purposes was that there would be minimal restrictions on the availability of foreign exchange, energy, spare parts, equipment and all other imports. This is a highly unlikely situation, but a starting point from which to examine shortages of supply against this projection of unlimited demand. In Chapter III the strategies required to cope with these shortages are set forth.

Unrestrained demand is expected to reach 2 million tons by 1990. Today actual consumption is about 1.1 million tons/year, but if the restraints caused by scarcity were removed then demand would be about 25% higher. Thus, a growth rate of about 8% a year has been estimated to take into account both today's unsatisfied demand and the growth in demand. The Transport Sector is the largest petroleum consuming sector, with demand for electricity generation growing at the fastest rate. In fact, half of the projected growth in demand is for furnace oil to be used in an expansion of NEC generating capacity.

Summaries of the expected growth in demand in the main sectors follow:

a. Transportation

Fuel consumption is roughly 50-50 freight and passenger. It is assumed that fuel needs for freight will grow in proportion

to growth in agricultural production, with no further decrease in the amount carried by rail. Demand for fuel for passenger transportation is expected to grow twice as fast as the growth in population, due to increased urbanization. Overall, the projected growth for this sector is 5%/year up to 1990.

b. Electricity

Although in 1983 petroleum for power generation was only 7% of total consumption, it is forecast to be over 30% by 1990. This is an increase of about 29% year, mainly to cover the large thermal generating expansion of Power IV.

c. Industry

Each of the major sectors was analyzed separately, e.g., cement, sugar, textiles, soap and oil, bakeries, etc. Based on substantial expansion plans, especially in cement, a combined petroleum consumption growth to 1990 of 6%/year was projected.

d. Agriculture

Demand projections were directly related to national plans for expansion of cultivated land and farm products production. However, this was offset by the expectation of considerable electrification of irrigation pumps (replacing diesel). As a result, overall petroleum demand growth in this sector is projected at only 6%/year.

A summary of the petroleum demand forecast for all sectors, in thousands of tons/year, is shown in Table 2-1.

TABLE 2-1

PETROLEUM DEMAND FORECAST (TOE)

	1982/83	1990/91	Yearly Growth
Transportation	601	875	5%
Electricity	81	638	29%
Industry	138	227	6%
Agriculture	149	172	2%
Household	56	71	3%
Commercial	39	60	5%
Total	1,064	2,043	8%

2. Supply

The availability of foreign exchange is of critical importance to all energy supplies. Petroleum supplies in particular depend directly on Sudan's foreign exchange position. If foreign exchange is inadequate for all imports, then all will be restricted, including petroleum. This is the situation at this time. In addition, thermal power generation will also be restricted by the inability to purchase furnace oil.

In the future when oil exports begin the situation will be slightly different, but the basic problem will remain the same. The choice then will be to export oil to improve the foreign exchange position or to consume it internally and forfeit the foreign exchange earnings. In either case the overall foreign

exchange balance will continue to determine how much oil can be consumed. This problem is shown in Figure 2-3 which gives the historical and forecest foreign exchange expenditures on imports and earnings from exports.

Recent foreign exchange deficits are shown to have been about $800 million to 1 billion. This very large gap is expected to grow over the next few years and then gradually shrink as crude exports increase. However, it appears that there will continue to be a severe restraint on oil supplies for at least the next five years and probably longer.

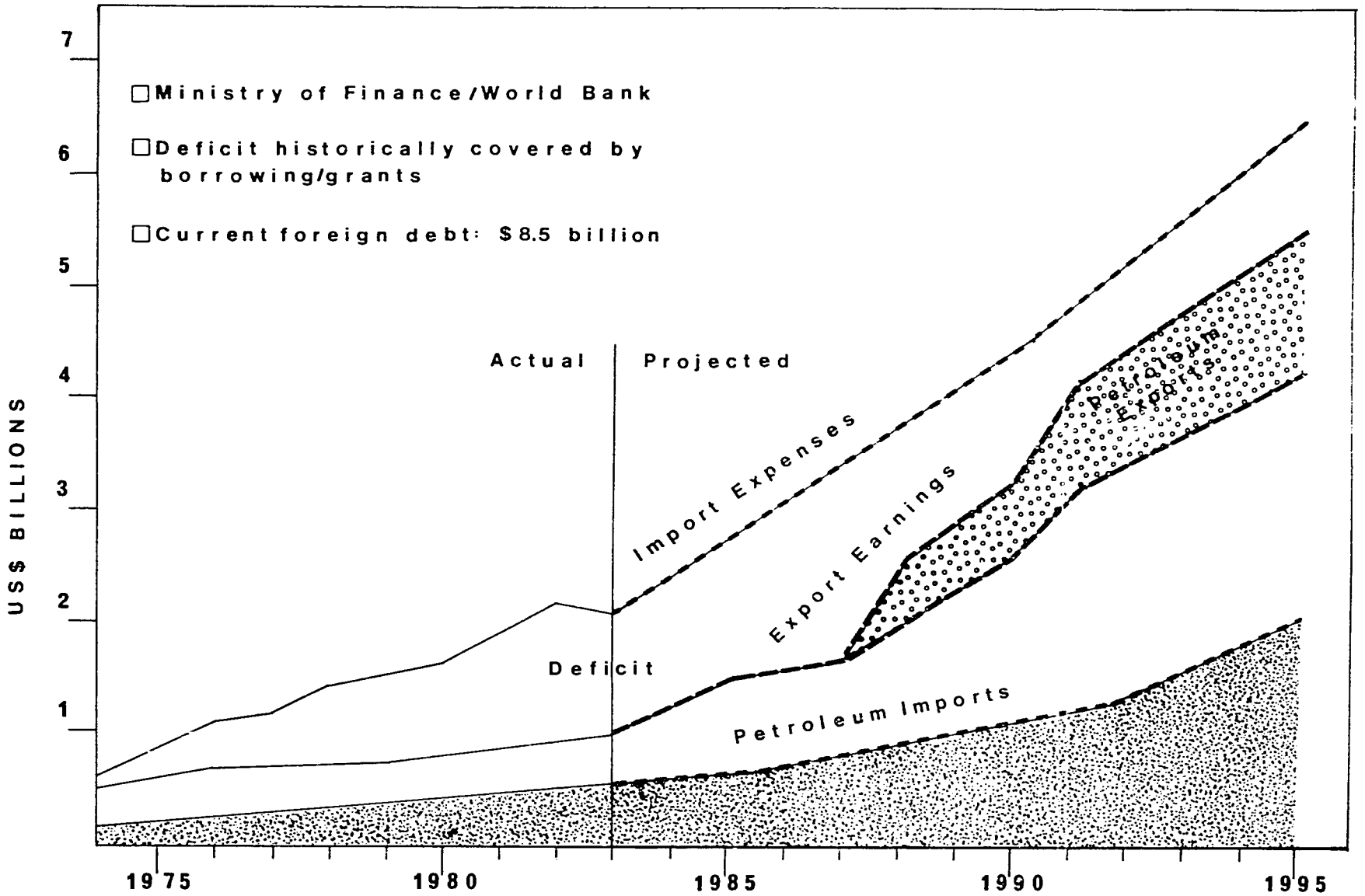


FIGURE 2-3. CONTINUING FOREIGN EXCHANGE PROBLEM.

The near-term petroleum financing grant should have a positive effect on petroleum supply, but the net effect is still uncertain. Also, future forecast growth in Sudan's export earnings should provide more foreign exchange for oil purchases. This is summarized in Figure 2-4 with the maximum increase in supply being due to the "Financing Facility."

Also shown in Figure 2-4 is a prediction of demand based on the continuation of the present tendencies for unrestrained demand. It can be seen that the petroleum shortage may decrease when new financing is available, but it is still likely to be substantial. Then, as demand continues to grow, the shortage increases and within five years is likely to be even larger than it is now - or about 500,000 TOE/year compared to the current 200 -300,000 TOE.

The effect of a lower rate of growth in demand, labelled "Historical," is also shown. This represents about 4%/year compared to the forecast 8%/year. It makes the point that if demand growth could be restrained by proper management, the petroleum shortage problem could be much smaller than it is likely to be. This point will be further elaborated when discussing new strategies.

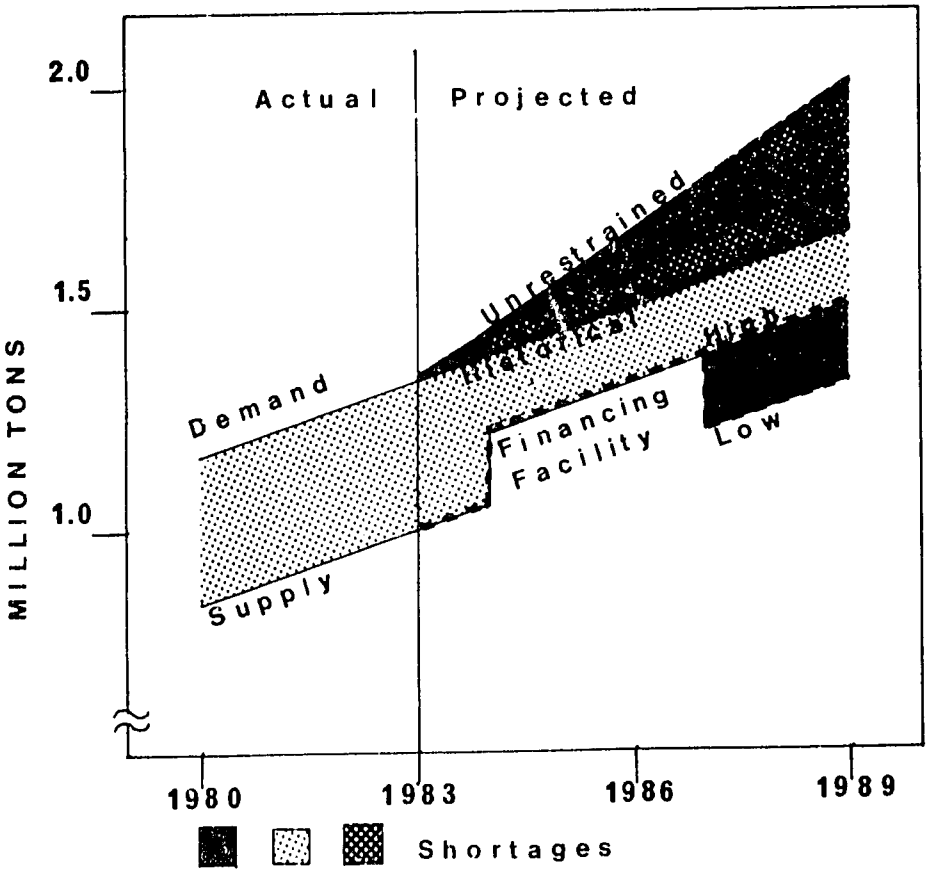


FIGURE 2-4. PETROLEUM DEMAND VS. SUPPLY; MANAGING SHORTAGE.

C. ELECTRICITY DEMAND AND SUPPLY

1. Demand

The forecasting of demand for electricity is characterized by uncertainty. Historically, demand has risen by approximately 9% per annum over the last five years. Delivered electricity, however, has grown by only 7% per year. The current shortage situation is equally unclear. Estimates of unsatisfied demand vary by 100 GWH depending on whether only currently connected demand is considered or if the best guess of unconnected loads, unsatisfied even by self-generation, are included as well.

Estimates for future demand vary from an annual increase of 6% to over 9%. This wide gap is unsatisfactory for planning purposes since in 12 years the demand would range by 30% from 2600 to 3500 GWH.

Three forecasts are presented in Figure 2-5: 9%, 6.3% and 7.5%. The 9% growth was used in the original Power IV planning document. 6.3% represents an estimate of growth in electricity required to satisfy assumed economic growth. This figure is based on historical experience: a 1.58% growth in electricity consumption is required to support a 1% growth in GDP. Given a 4% per year growth in GDP, electricity will then grow by 6.3%. The 7.5% forecast is derived from the World Bank's end use sectoral projection of 7.8%. As a basis for planning, the 7.5% is applied to the 1983/4 actual energy generated plus the estimate of unmet demand.

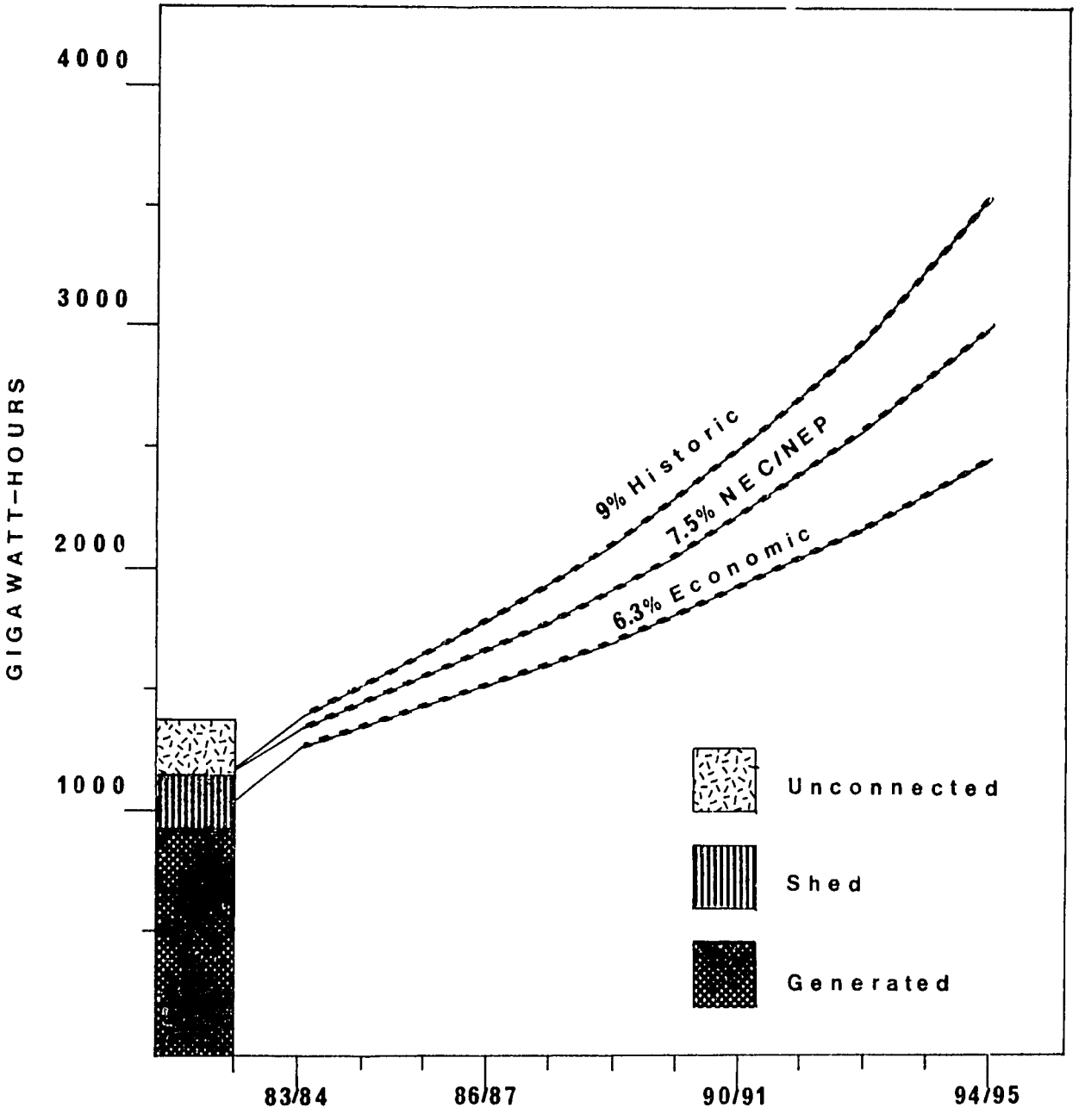


FIGURE 2-5. ELECTRICITY DEMAND PROJECTIONS, BLUE NILE GRID.

Clearly considerable judgment is required here. The 7.5% forecast is used as the "best guess." A comprehensive end use sector-by-sector projection should be carried out at the earliest possible moment.

2. Supply

With the completion of Power III by 1985 and other changes, the generating capacity of the Blue Nile Grid system will have increased by 80% or 180 MW over the past three years. This increase has been split 80 MW hydro and 100 MW thermal.

As shown, in Figure 2-6a, this higher capacity will cover increasing demand for several years. At the higher rate of increase of 9%, the capacity will be used up within a year (by 1986). At that time, if no new capacity has been built, the shortage problem will begin again.

The current strategy is based on financing substantial additional thermal capacity as soon as possible; hopefully the first units of Power IV will be operating by 1986 (Figure 2-4b). This strategy envisions building about 140 MW of thermal generating capacity by 1988 to give substantial operating reserves as backup, even with a high demand growth, if enough foreign exchange is available to purchase the furnace oil required to run all this thermal capacity.

The efforts to obtain the approximately $250 million financing required for Power IV have not yet been fruitful. At this time it is doubtful whether as much thermal capacity as

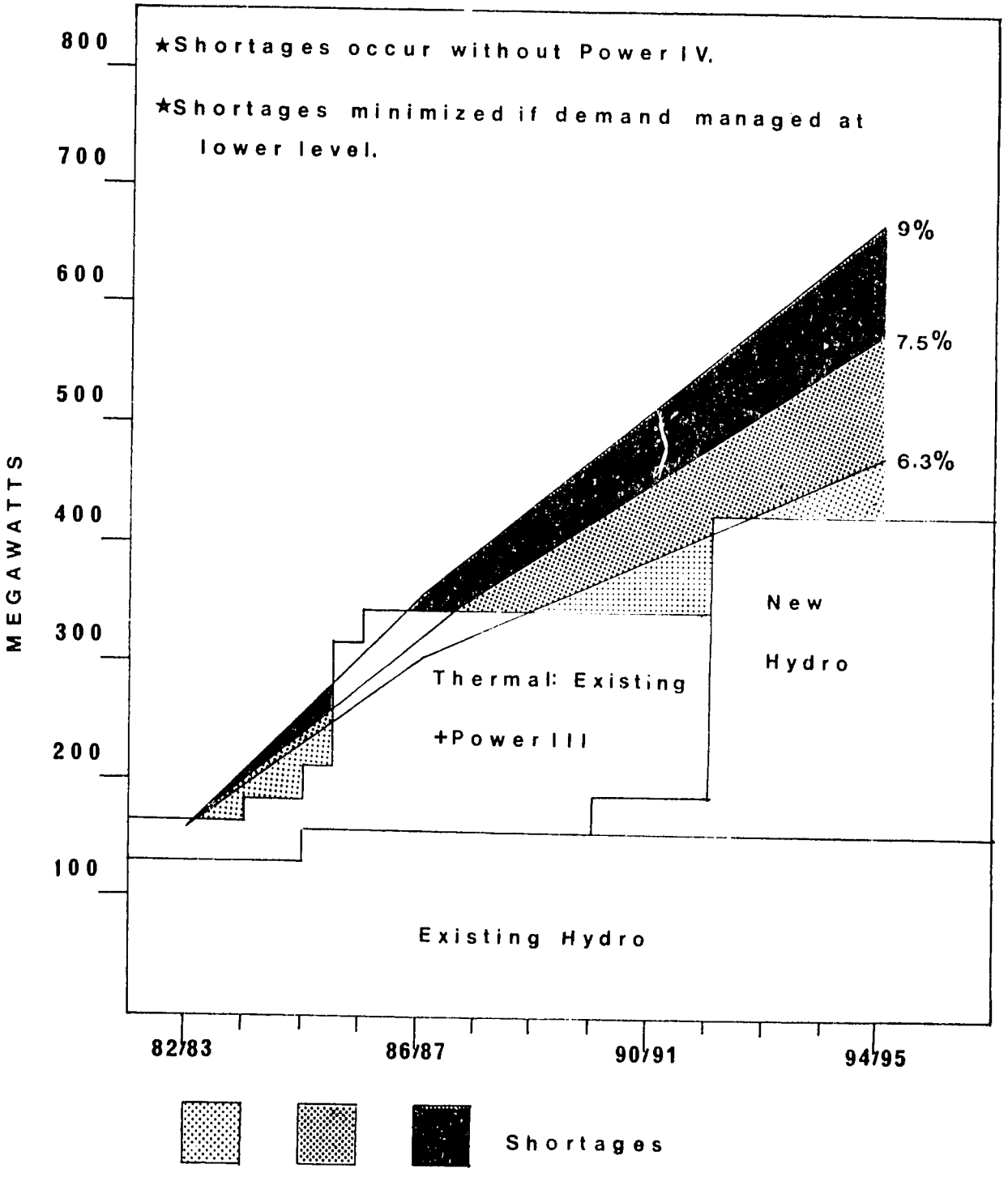


FIGURE 2-6a. BLUE NILE GRID FUTURE DEMAND AND SUPPLY (MAY CONDITIONS).

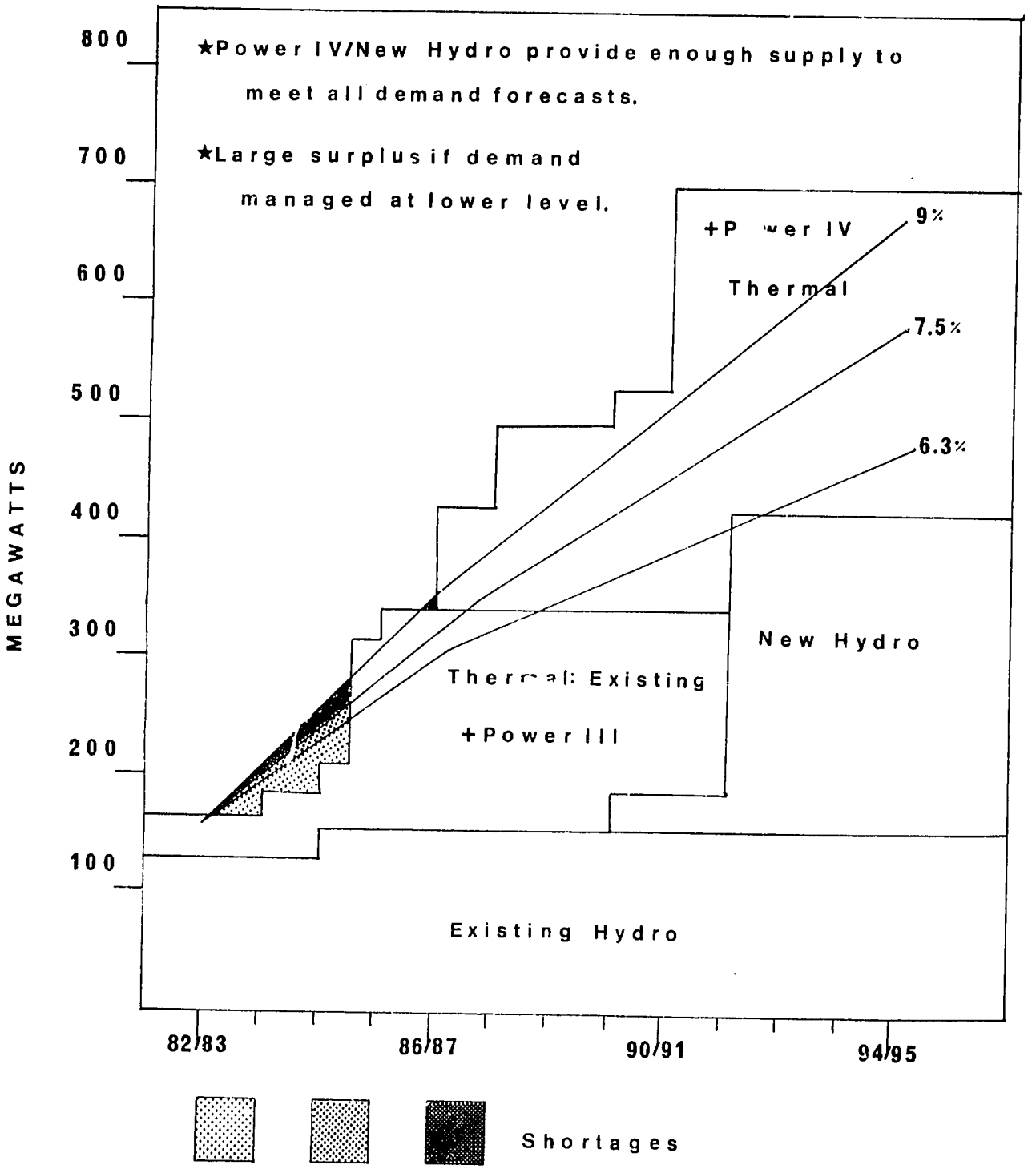


FIGURE 2-6b. BLUE NILE GRID FUTURE DEMAND AND SUPPLY (MAY CONDITIONS) WITH POWER IV.

planned can be built, and as early, as the current strategy anticipates. In this case the shortage will grow after 1986, and reach about 20% within three years.

A slower rate of demand growth would provide time to adopt a different generating strategy, one of expanding hydroelectric with minimal thermal capacity. This point is demonstrated graphically in Figure 2-6a, where at the low growth rate shortages could be minimized for another two-three years, up to 1989. These points will be addressed more fully in Chapters III and IV on strategy and plans.

D. WOOD FUELS DEMAND AND SUPPLY

1. Demand

The basic assumption is that wood and charcoal demand will grow in relation to expected population growth. This is based on the belief that, because of tradition, the Sudanese will continue to prepare their food the same way in the future. It is also based on the expectation that petroleum substitutes will not be generally available.

Since urban growth will be faster than rural, and the urban dweller prefers using charcoal rather than wood, charcoal demand will grow faster than wood. The specific estimates are presented in Table 2-2.

TABLE 2-2

CHARCOAL AND FUEL DEMAND PROTECTION

	1982	1990	2000
DEMAND (000 TOE)			
Wood	2,810	3,930	4,920
Charcoal	1,630	2,220	3,230
GROWTH (%/YEAR)			
Wood	- - -	2.1	- - -
Charcoal	- - -	3.9	- - -
Population	- - -	2.9	- - -
Urban Population			
% of Total	28		47

2. Supply

Over the last 50 years many acres of forests have gradually been chopped down to provide fuel and farmland. Recently, the pace of this deforestation has accelerated as large areas have been cleared for mechanized farming schemes and the shortages and escalating costs of fuel have forced more and more people to turn to wood and charcoal for cooking and other domestic uses.

As shown in Figure 2-7, the result is that forests have receded further and further from major urban centres. The source

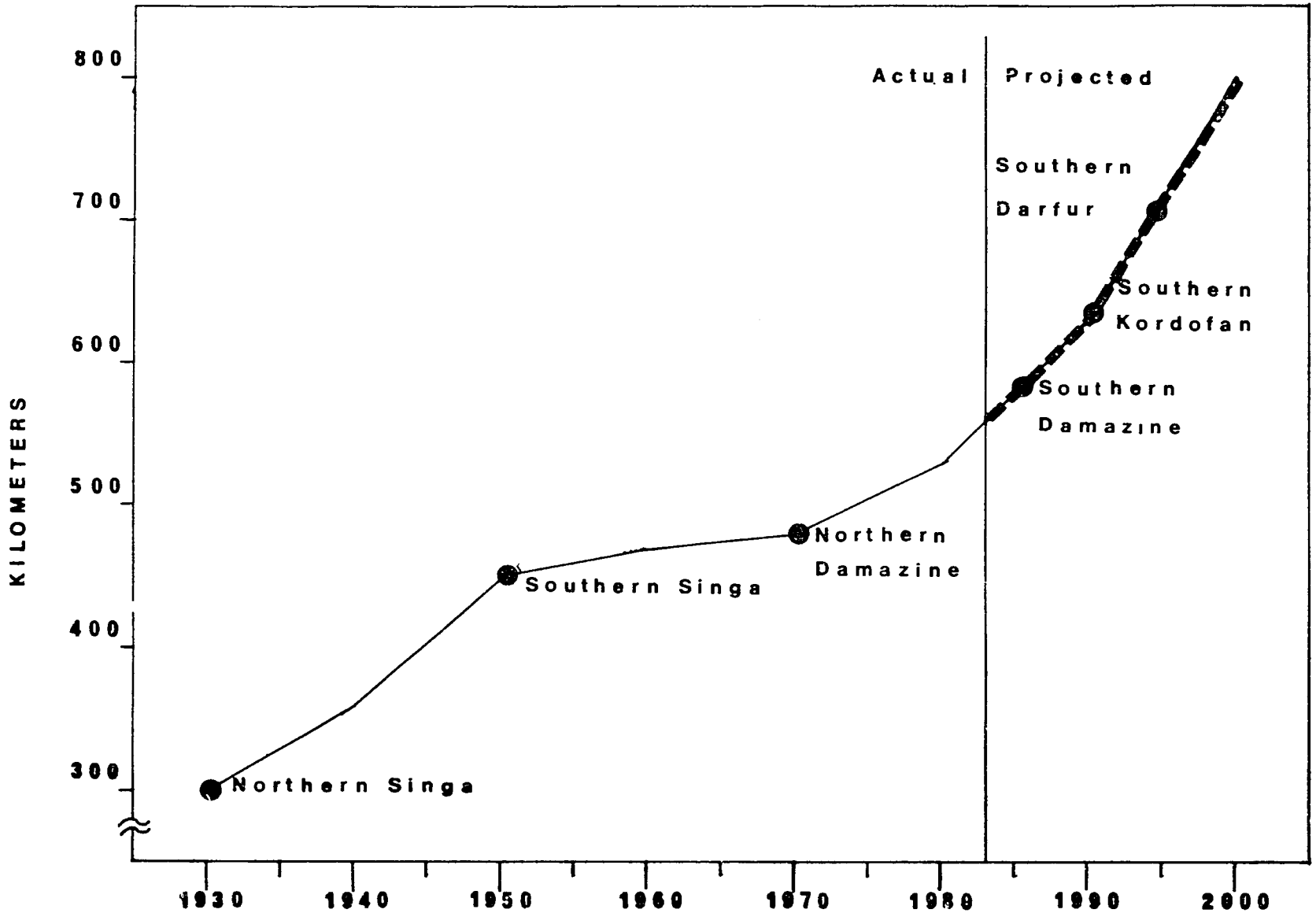


FIGURE 2-7. CHARCOAL PRODUCING CENTERS-DISTANCE FROM KHARTOUM.

of charcoal supplies for Khartoum is now Southern Damazine, a distance of some 600 KM away. Distances have doubled over the past 30 years, so the price of charcoal is effectively doubled by transportation costs. This is likely to increase over the next few years.

In the longer term, the problem is even more serious and will probably involve the complete denudation of forests from all parts of the Sudan except the extreme south. The consequences of this in terms of human hardship, effects on the climate and the economy will be very serious.

The rate of cutting in response to increased demand far outpaces replacement. As the inventory in Figure 2-8 shows, if current practices continue the number of trees will be reduced by half in ten years and within 15 years will have almost completely disappeared.

This problem is widely known, although perhaps its magnitude and eventual consequences have been seriously underestimated. A number of research projects are currently engaged in various aspects of forestry management and will provide a considerable body of knowledge to be applied if and when serious efforts are made to arrest the decline in forests. But such efforts need to be made now before it is too late.

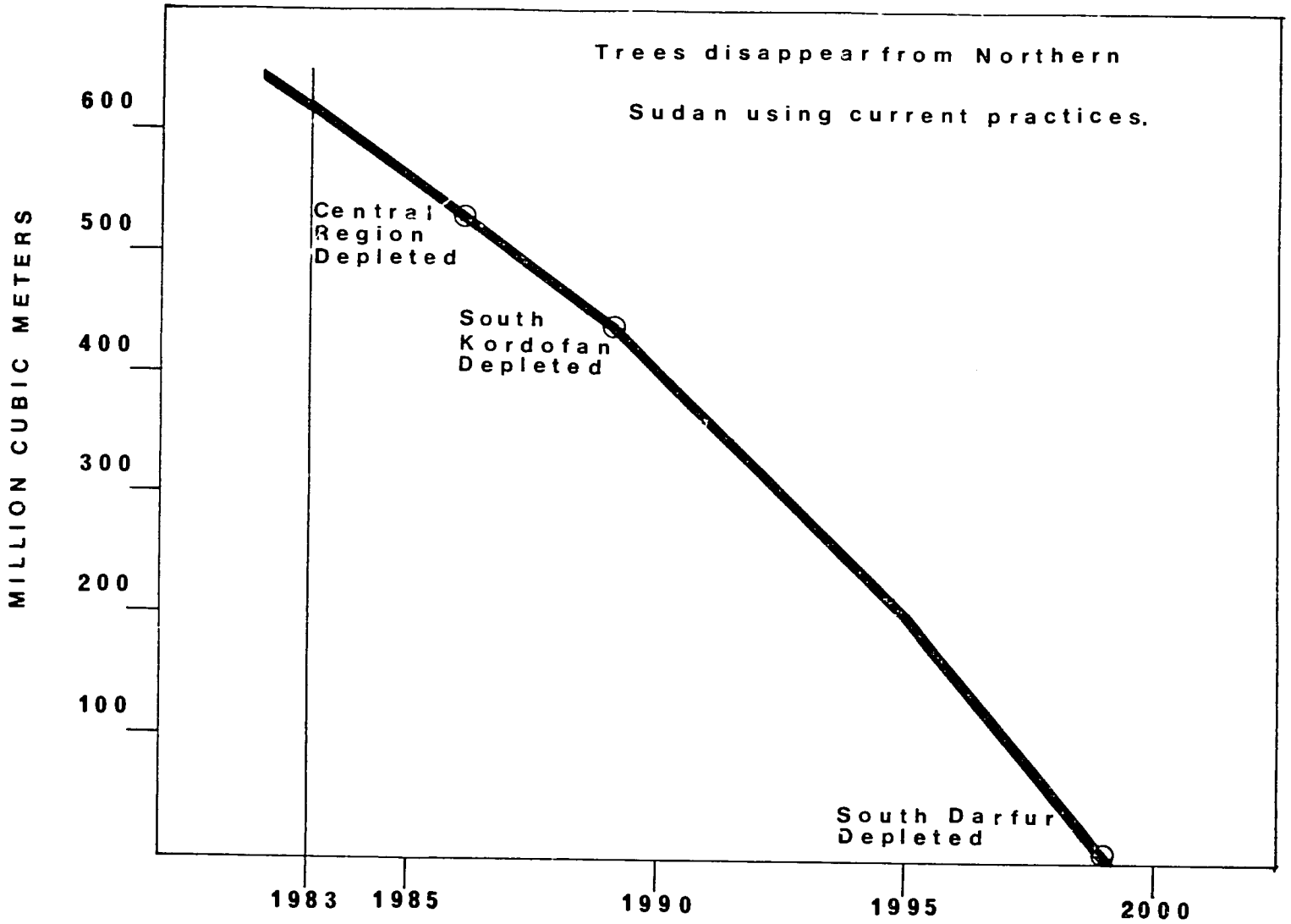


FIGURE 2-8. TREE INVENTORY.

OUTLOOK: POSSIBILITIES FOR CHANGE

The planning process has shown that much can be done to influence the crisis situation positively, if the approach to change is scientific, bearing in mind that:

* The energy crisis is a national issue and not only a concern of the Energy Sector.
* Tha country has to learn to live with the crisis for a long period, and so try to minimize its negative effects and develop policies, institutions and manpower for longer term, more effective solutions.
* Awareness and dedication to change must be promoted to help understanding of unpopular measures and secure nationwide participation as well as coordination.

Possibilities for change, short and medium term, cover the whole technical strata of the Energy Sector, primary and secondary resources, supply and damand and its interrelation as well as the end use.

A. RESOURCES AVAILABLE

1. Oil and Gas

Oil in the Chevron concession area and gas in tha Red Sea area, having already been discovered, will contribute in the

medium and long term in partially solving the importation and balance of payment problems.

Tha Sudanese government and its institutions, as well as international companies, the World Bank and USAID, are coordinating efforts to solve materialization problems of this resource.

2. Hydro

Potential hydro sites for power generation have been identified. Feasibility studies are underway. Although large-scale hydro requires huge financing and long lead times, an early start on this effort will shorten the crisis period. Components of this program within the next ten years are the completion of Merowe, the heightening of Roseires and the Setiat (Atbara River) project.

Mini-hydro development needs intensive surveying and economic evaluation. Sites identified in southern regions and western regions as well as middle regions should be pushed to improve the regional situation. Though small in size, their impact is tremendous due to the low level of regional demand. The 2 MW Kinyetti River project, where construction will begin in early 1985, provides a model for future development of this resource.

3. Biomass

The biomass resources available are wood, charcoal, agricultural waste and animal dung. The significance of thase resources is derived from thair impact on the ecology and their

use by the massive poor population. Measures to improve the biomass situation should cover:

a. Securing renewal of resources.

b. Improving traditional technology.

c. Introducing new technologies (biogas, gasification, etc.)

Provided that the necessary planning funds are secured, positive effects from biomass could be seen in the short and medium term due to the fact that most technical problems are solvable.

4. New Energies

There are ideal meteorological conditions in Sudan for the application of windmill technology in northern Darfur and the middle region. Demand, especially for pumping water and other applications, is apparent.

Solar energy, although it needs intensive research, has considerable implementation possibilities especially in solar water heating for laundries, hotels and hospitals and solar cookers for household use.

5. Future Resources

Sudan's energy resources should be identified and evaluated systematically. Efforts should be concentrated in areas of maximum availability. These areas are: oil and gas, uranium, geothermal energy, coal and peat.

B. SUPPLY AND DEMAND

To manage the crisis in the short term, there are more effective measures than direct allocation to promote change:

1. Pricing is the most effective supply-demand control tool, as it limits consumption to necessary needs, forces conservation, directs supplies to the most economic choices available, and creates chances to enrich the energy mix with new local resources.

2. Industry, transportation, agriculture and household equipment manufacturing should be monitored by regulations and standards based on energy efficiency.

3. Subsidies, taxes and other economic incentives should be carefully implemented to encourage the commercialization of new and renewable energies and to encourage conservation. Appropriate measuring devices should be used to monitor the effectiveness of these incentives.

4. Choices within sectors should be analyzed to determine energy effective choices, i.e., river and rail versus road transport, pipeline, power station or fuel transport versus power transport or national grid expansion, mass transport versus individual transport and so on.

5. Analyze and reduce the tremendous technical and non-technical losses within the physical system of the Energy Sector: refining, conversion process, power systems, transmission, etc. Implemantation of conservation measures within the sector will create an example for the whole economy.

6. A series of small-scale industries could be developed from the importation needs of the Energy Sector, if the Private Sector is involved and assists in the identification of commercial areas. Implementation of import substitution within the Energy Sector through creation of free enterprises will reduce foreign currency needs and reduce brain drain.

7. Research can improve traditional technologies, especially in the field of biomass, as well as help commercialization of energy conservation measures.

8. Since the Energy Sector is capital and energy intensive with complex operations, it needs modern management practices. Accordingly, Energy Sector corporations must have a free hand to do business on a purely commercial basis, to secure proper decisionmaking and to improve terms of service. The result will be to realize technical and economic efficiency.

C. ENERGY SUBSTITUTION

Energy resources, in secondary form and in the end use stega, are substitutable. This phenomenon paved the way for the domination of electric power in developed societies, due to its operational merits in industry and households.

In this era of high energy costs the substitution phenomenon should serve to optimize the energy mix and enrich the economy. This is true especially in developing countries, where technical choices are still at an infant stage. For Sudan a series of substitution possiblities should be encouraged. To be discouraged

definitely is the domination of oil in power generation and household use. Monitoring of substitution is an area where intensive research should be instituted, focusing on the economic evaluation of resources, with special consideration of age, renewability, technical efficiencies, the technology involved and future as well as present economic benefits to the nation. For Sudan the following goals should ease the present crisis situation:

1. Improve refinery yield and the economics of utilization of imported oil. The different uses of oil products should be studied from the point of view of substitutability.

2. Keep the generation of power in the BNG at 80% hydro and 20% thermal. This is a healthy ratio, which will be disturbed by the thermal additions of Power III and IV. To restore this ratio in the future, utilization of hydro generation should be emphasized.

D. AGRICULTURE AND INDUSTRY

Biomass-intensive consumption is destroying the ecological balance of Sudan. If oil supplies are available, the natural short-term trend will be to substitute kerosene, LPG and gasoil for biomass. The long-term trend should be to improve biomass technology, (i.e., plantations, introduction of biogas) and develop other renewable technologies as substitutes. If this issue is properly mastered, more local oil could be exported and better efficiency in utilizing local resources could be realized.

New and renewable energy technology, like windmills, are potential and promising applications for the future. Research and economic subsidies are necessary at this stage to overcome the implementation and commercialization problem. The substitution ability of these resources is strong in the existing crisis situation, especially due to nonavailability of other resources.

E. END USE

End use of energy covers every activity, productive and nonproductive, throughout the Sudanese economy. End use efficiencies are very low, due to:

* lack of Awareness.
* Arbitrary Choices of Technology.
* Lack of Energy Conservation.
* Lack of Energy Measuring Devices.
* Lack of Regulations and Standards Governing the Efficient Use of Fuels.
* Lack of Economic Incentives To Take Conservation Measures and Incentives.

Many countries have achieved good results by controlling demand through energy conservation in the short term.

Sudan could utilize this potential for change by completing its energy balance analysis, through end use efficiency auditing, and promoting public and private energy consumer awareness.

CHAPTER III

STRATEGIES FOR CHANGE: THE NATIONAL STRATEGY

A. THE STRATEGY IN THE OVERALL NATIONAL CONTEXT

The formulation of energy strategy based on achieving economic security is practically the definition of the role of the Energy Sector within the comprehensive strategy of the State which comprises the military, economic, social, political and diplomatic aspects. The strategy therefore derives its objectives from the overall, especially the economic policy of the country. The economic policy has to teke the energy efficiency of the economy as a whole into consideration.

B. OBJECTIVES

1. Provide an adequate and reliable supply of energy to support sustainable economic growth and to improve the quality of life.
2. Maximize development and utilization of indigenous resources to minimize dependency on energy imports.
3. Efficiently use all forms of energy to get the most economic value of the energy and minimize the cost of the energy to the country.
4. Develop local capabilities in manpower and technology to support the above three objectives.

The strategy to realize these objectives addressed resources (supply) and demand.

C. RESOURCES STRATEGY

A sound resources strategy has to satisfy the domestic energy demand from local resources as much as is economically feasible, especially those which can only be consumed internally.

1. Hydro Potential

This is the most important energy resource for electric power generation in the Sudan today and for generations to come. The present approach where hydro is the base electricity supply and thermal generation is a supplement only has to be maintained.

Hydro projects are to be considered basic and long term in the infrastructure for the development of agriculture and industry as well as providing a source of power. Hydro energy is a substitute for imported, and potentially exportable, energy resources. Another advantage of hydro resources is that they are clean, renewable and inexpensive to operate.

The biggest obstacle to development of the resource is obtaining the large amounts of capital required. Due to the remote location of many sites and the complexity of construction, hydro projects are costly, requiring considerable lead time and extensive effort. Such issues as the geopolitical aspects, infrastructure, and demand growth must be addressed. Full development of this resource involves cooperation and interconections with neighboring countries. The benefits of such a system of interconnections are to be studied.

2. Wood Fuels

Wood fuels constitute the largest energy resource providing 80% of the supply for use by almost all the people in the

country. The resource has been over exploited and is fast disappearing. How to maintain it will be one of the most important issues during the next 15 years. To address this issue, a national consensus must be achieved. Close cooperation of all concerned institutions will be of vital importance.

The basic strategies required are:

a. Resolving the competition for land use.

b. Initiating nationwide and multiple approach efforts to grow trees.

c. Efficient use of wood and charcoal.

d. Substitution of other resources, especially other renewables.

3. Petroleum

The country already has identified limited quantities of petroleum and natural gas reserves. The geological prospects indicate the possibility of additional reserves in the future. The following strategies are designed to exploit known and potential future resources:

a. Encourage a high level of exploration activities consistent with the long-term interests of the country.

b. Encourage rapid development of oil discoveries and maximize exports rather than encouraging unnecessary internal consumption.

c. Locally refine indigenous crude when justified to reduce the cost of securing essential supplies.

d. Seek innovative ways to exploit nonexportable oil and gas discoveries for local use.

e. Develop Sudanese expertise to better utilize this important national resource.

4. Renewables

There are considerable renewable resources in the Sudan which could be of strategic importance in substituting for oil, electricity, wood and charcoal; in assisting in rural development; and in improving the quality of life in rural areas. These strategies are designed to exploit economically the potential of these resources as rapidly as possible.

a. Apply proven technologies which are economically viable such as:

- Nonwoody biomass technologies, especially direct combustion, biogas, densification, gasification and ethanol production.
- Mini-hydro technology.
- Wind for water pumping in remote areas.
- Solar for essential services, and commercial hot water applications; photovoltaics for remote electrical supply.

b. Launch an intensive applied research program and field testing for technically proven and economically not yet viable technologies.

c. Develop implementation and dissemination strategies to promote the application of these technologies on a commercial basis.

5. Coal

Although some occurrences of coal have been noted in Northern and Eastern Sudan, no workable coal deposits have been reported. This is due in part to inadequate prospecting and exploration and the availability of cheap abundant alternatives in the past. It is therefore necessary to launch an intensive coal exploration program. The Geology Department is well staffed and equipped to carry out such a program.

Any discovery of workable coal deposits would affect fuel imports and the electricity generation program.

6. Uranium

If economic uranium deposits are identified, this resource will be exploited for export to add to foreign exchange revenue. It can also lead to working out a nuclear long-term energy program for the future. Therefore, prospecting and exploring for this resource are to be promoted because of its strategic importance and potential future economic impact.

D. DEMAND STRATEGY

Not enough attention has been given in the past to demand. Emphasis has been solely on supplies to meet all and every demand consumers placed on the system. Because of the high cost of energy, it is necessary to introduce strategies which will more effectively use the energy supplies which can be made available. To accomplish this end the following strategies are needed:

1. Manage demand to the higher priorities and most economic uses and discourage low priority and uneconomic uses through economic tools such as prices, taxes, etc.
2. Control consumption with energy conservation laws and regulations; establish minimum energy efficiency standards.
3. Encourage energy conservation to achieve the same result by:
   a. A public awareness campaign to better inform consumers of their energy consumption choices.
   b. Energy saving capital investments.
   c. Structural changes using more energy efficient systems, e.g., mass transportation versus private transportation.

E. TOOLS TO IMPLEMENT STRATEGIES

With completion of the first National Energy plan, the challenge ahead is to implement the strategies for change and improvement by enlisting the support and active involvement of the whole government, donors and the people of Sudan. Successful implementation of the Plan will require commitment of substantial financial resuurces, changes in organization and management practices, and follow through. Studies have shown that the best measures to implement the plan are the following:

* Initiate a unified and complete energy information system to facilitate the decisionmaking process.
* Revise the Plan periodically and start regional planning.
* Develop innovative ways and means to finance the plan and to overcome the lack of investment in the Energy Sector.
* Develop and modernize the organization of the Energy Sector and improve coordination and cooperation among its sectors.
* Encourage applied and field research.
* Develop technical cooperation with developed and underdeveloped nations.
* Create public awarness.
* Develop local manpower.
* Attract Private Sector initiatives, especially in the development of renewable energy resources.

SECTORAL STRATEGIES

A. PETROLEUM

1. Overall Demand/Supply Objectives

The future problem which Petroleum Sector strategies must address is a continuation of what has been happening in the past: too little supply and too much demand. Today, as in the past, this gap is being handled by "allocation." That is, shortages are allocated amongst consumers on the basis of decisions made by various government units. Of necessity, these decisions must discriminate between different geographical regions, different industries, different classes of consumer and, eventually, between different individual consumers.

Lengthy worldwide experience has shown allocation to be a last resort procedure only, to be avoided if at all possible, and to be simplified and minimized when unavoidable. This is so because consumers are better able to make the many daily purchase decisions for using petroleum, based on the alternatives available to them. Thus, the objectives of the petroleum strategies for the Sudan are to:

Manage demand and enhance supply so that an economic balance is achieved without the need for continuous allocation.

2. Strategies

Supply and demand can be economically brought into balance by increasing supply and decreasing demand. In the Sudan, the gap is so large today that, realistically, only drastic strategic actions taken consistently over several years have any chance of meeting this objective.

The strategies must not only overcome the large gap between supply and demand that exists today, but reverse the trend that is causing this gap to increase. Accordingly, a new look is required at the strategies now being followed and revisions made where appropriate.

In Chapter II, current strategies and the expected future supply/demand results were detailed. The new strategies required for the future are developed below.

a. Strategies To Increase Supply:

* Ensure that the share of total foreign exchange to purchase petroleum is appropriate to its importance to the economy.

The Sudan has many claims on its limited foreign exchange for buying imports of all kinds. Since petroleum is one of the main ingredients of economic growth, adequate priority must be given to providing sufficient foreign exchange on a timely basis for its purchase.

* Intensify and diversify exploration activities and subsequent development of hydrocarbon resources.

The Sudan has encouraging, proven commercial oil deposits with the likelihood of more. There is every incentive to see to it that existing and potential resources be developed as soon as possible.

* Develop internal uses for nonexportable oil and gas discoveries

Small known deposits of both oil and gas have development potential and could be used within the country to replace petroleum imports in areas such as thermal power generation.

b. Strategies To Manage Demand:

* Reduce nonessential demand by all available means, consistent with the goal of managing demand while enhancing economic growth and supplying the most productive and export sectors.

The main cause for the large and growing demand/supply gap has been the substantial growth in demand. This has partly been necessary to support real economic growth, but consumption has also been greatly increased by much lower priority uses.

The most effective way to both reduce unnecessary demand growth and to steer it towards economic activities is through use of the price mechanism. A strategy of deliberately managing

product prices, product-by-product, at appropr
levels to moderate and direct demand growth, wou
significant benefits over a period of years.

As an additional tool to discourage nonessential demand growth, restrictions and/or taxes can be applied selectively to petroleum-consuming machinery and equipment.

A third component to reduce unnecessary demand is through increasing the efficiency of use - "conservation." Such an effort, by educeting consumers to meet their needs with less petroleum, would complement the economic incentives established through using price and tax mechanisms.

* Maximize electric power generation from hydro power, not imported oil.

The construction and maximum use of hydro power capacity substitutes an indigenous resource for an expensive imported one.

* Use biomass and other renewebles to replace oil in industry, agriculture and households.

Considerable amounts of crop residue are already used to generate steam in sugar refining, and it is anticipated that a variety of other economic uses can be found over time.

* Pursue energy efficiency in transportation through structural changes.

The biggest consumer of petroleum in a country the size of Sudan is the Transportation Sector. Some moderation of growth in demand may be obtained by pricing and conservation measures.

However, major changes should also be sought by rethinking some basic transportation strategies; for example, the relative advantages of rail versus road transport.

b. Expected Results

It is not possible to estimate the detailed impact of each strategy on the supply/demand balance. There are too many uncontrollable and unquantifiable factors, such as the availability of foreign exchange, the price of oil, economic versus nonessential demands on oil, and so on.

However, it is feasible, and useful, to forecast the magnitude and direction of the combined effect of all these strategies. The table below, "Demand vs. Supply: Managing Shortage," projects the shortage over a range of assumptions and shows the potential impact of the new set of strategies.

Table 3-1

DEMAND VS. SUPPLY: MANAGING SHORTAGE

	1983	1986	1989
Base Shortage With Current Strategies			
000 Tons	260	300	540
%	25	22	40
Reduced Shortage With New Strategies			
000 Tons	260	140	140
%	25	10	9

The above analysis is based on these assumptions:

* The rate of demand growth can be cut in half without reducing economic growth.
* Foreign exchange for oil purchases grows at the same rate as forecast total Sudan exports.

The results show that, without any change in strategies, the current problem could become much worse in a few years. However, a big improvement is possible if the right mix of strategies is vigorously applied. Conceivably, within five years or so, the need for allocation could be sharply reduced.

B. ELECTRICITY

1. Overall Demand/Supply Objectives

Three central objectives guide the formulation of strategies for the electricity sector:

a. Eliminate power shortages and unreliability of supply.

b. Provide electricity at the lowest possible cost to meet the needs of a growing economy. (Electricity shortages must not constrain economic development.)

c. Expand services to regions and smaller towns in order to promote economic activity in these areas and improve the quality of life for the populations.

2. Strategy: Elements & Constraints

ELEMENTS: The fundamental elements of this strategy are:

a. Gain energy from the existing system by eliminating present bottlenecks and improving efficiencies in production, distribution and consumption of electricity.

b. Plan and manage future growth in demand to ensure economic development but discourage unnecessary consumption. Use conservation and load management, among other measures, to achieve this result.

c. Emphasize development and expansion of hydro power generating capacity, minimizing thermal as much as possible.

d. Utilize local resources and the financial and managerial capabilities of the Private Sector to expand electricity systems, with special emphasis on this participation in the regions.

CONSTRAINTS: The strategy for achieving these objectives recognizes and allows for several important constraints:

a. Limited access to capital to finance expansion primarily because of the large debt burden facing Sudan.

b. Limited foreign exchange for current expenditures, such as fuel and spare parts.

c. A weak infrastructure for transporting fuel oil for thermal generation.

d. Lack of a stable, proper management system, resulting in a scarcity of trained managers and skilled technicians.

e. Difficulties in coordination among the various institutions.

Accordingly, the Electricity Sector strategy amphasizes more efficient use of existing resources and maximum reliance on indigenous energy potential.

Thus, for the Blue Nile Grid the essense of the strategy (for the next five years) is to slow down demand growth below that currently forecast by careful planning and management of that demand and by more efficiently using existing resources. This slower demand growth will then allow the Energy Sector and the NEC to minimize new thermal generation in the near term so that financial, management and planning resources can be focused on developing hydro power sites as rapidly as possible. Accordingly, in the early 90s the BNG will again be predominantly hydro based and the demands of the Sudanese economy can be fully realized.

Failure to slow down demand growth and realize improvements in efficiency will force the Electricity Sector to pursue a riskier thermal-based expansion strategy. This alternative will require substantial thermal capacity additions in the late 80s, or the shortages and unreliability currently plaguing the system

will reoccur. The fuel oil consumed by thermal generators will require sizable amounts of foreign exchange and a vast improvement in the infrastructure for transportation of fuel. Moreover, in order to realize cost savings in the long run, more hydro capacity will be required by the mid-90s.

This alternative is risky in that the strategy requires a guarantee of foreign exchange to purchase the fuel oil and a viable means for transport to the power station. Realizing both conditions appeers problematic at this point in time. The dangers inherent in this approach are that capital will not be raised in time, new units will be delayed, and because funds will be used for tharmal units, subsequent hydro expansion will never materialize. In addition, a high probability exists that if thermal units are financed and built, output will be limited by a lack of fuel.

These dangers, though, must be weighed against the risks in the hydro-based strategy. These are:

a. That demand will not (or cannot) be properly managed to limit growth without hurting the economy.

b. Delay in construction of hydro units caused by financial and infrastructure obstacles will expose the grid to a shortage situation in the late 80s.

On balance, however, the hydro-based strategy is less risky overall, and more feasible and economical in the long run. Vigorous efforts, though, will still be required in the short term to control demand and improve efficiency.

C. WOOD FUELS

1. Overall Demand/Supply Objectives

The projection in Chapter II for continued and drastic reduction in Sudan's forests is unsatisfactory. The questions are: "Can the outlook be improved? How much? How?"

The record in Sudan and other countries is not encouraging - there is no history of a major reversal, or even stopping, of the disappearance of forests. The historical record is equally bleak in other countries where it has been neccessary to reduce the use of wood/charcoal as the main fuel of the mass of the population. But the Sudan now has a last chance to try to do what it , and others, have not done in the past.

If Sudan cannot, or will not, stop the continued removal of forests, the Sudan will be a different - and poorer - country in a few years. Wood/charcoal will become an expensive luxury, especially in the North. It will no longer be a universal staple that everybody uses for his many needs - for cooking, heating, and building.

Life, of course, will go on, but it will be different. The richer ones will clamor for kerosene and butagas, which the country cannot afford to import. The poor people will go without wood - or use whatever material they can find. And the country will look different: no longer trees to nourish the land and the people - but bare landscapes and encroaching desert.

The key question is: "Can this grim outlook be changed?"

Very little has been done in the past to change the inevitable - but this is not a technical problem. The Sudan, fortunately, has a wealth of know-how, experience and highly qualified people in forestry. Rather, the problem is one of the society. The society treats trees as an unlimited resource, requiring no care or attention. Society gives higher priority to:

* Clearing forests to expand farming.
* Animal grazing.
* Satisfying immediate needs, not the long term.

To make any changes in this grim outlook for the forests, fundamental changes will have to be made in the attitude of society. To do so will require that all segments of the country agree that it is worthwhile to join together in the effort - the political leadership, the government bureaucracies, the consumers, the rural population, the farming interests, and so on.

As a first step in seeing what changes can be made, the following objective is proposed:

Provide a long term, sustainable supply of wood to meet the needs of the population, at an affordable cost, while preserving the ecology of the Sudan.

The key phrases are "long term", "meeting the needs", "affordable cost" and "acology." The purpose of stating the objective this way is so that all decisions affecting wood will be taken with a long-range view. That is, establishing a continuing and adequate supply of wood, to meet all the needs of a growing population, at a cost that both the poor and the rich can afford without harming the ecology.

2. Strategies To Reach The Objective

The problems are many and complex, and so must be the strategies. And they will be difficult to carry out. But the ones that are described below are required if the country is to have the chance to meet the objective. As in the Petroleum and Electricity Sectors, strategies must be developed to both increase supply and decrease demand.

a. To Increase Supply

The basic approach is both to increase the yield from the still-standing forests and to rebuild forests where they have already been destroyed. Specifically, the components of the supply strategy are:

1) Maintain existing forests - Increase the productivity of the existing resource by improving care and protection.

2) Establish new forests - There are two components of this strategy. The first is to encourage the growing of trees on irrigated

lands integrated into the existing farming activities. The second is the planting of large forest tracts on idle rainfed lands. Both strategies, expanding forests and managing the present ones, must be supported by appropriate applied research and development activities.

3) Expand supply source - Although adequate forest reserves exist in the far south of the Sudan, they are not an economic supply source now because of the high transportation costs to the major consuming centres. A systemwide approach to transportation incorporating river, rail and truck is required to expand the available supply at an affordable cost.

b. To Decrease Demand

The basic approach here is to both improve the efficiency of the use of the wood, as well as to develop substitutes for the consumer. Specific strategies are:

1) Increase the efficiency of the wood and charcoal stoves in use.

2) Improve the efficiency of the charcoal production process.

3) Provide the consumer with economic and attractive alternatives.

The consumer is free to choose - providing he has a choice. Besides animal and agricultural wastes (which are very practical in rural areas) some new possibilities, like biogas, will help to a great degree if proper economic designs are developed and incentives for Private Sector commercialization are introduced.

Petroleum as a substitute is not feasible on a large scale because of the inability of the country to finance additional supplies. Petroleum may have a supplemental use, however in certain special cases. It should be noted that if the objective stated for wood fuels supply and demand cannot be reached and biomass and other renewables are not developed as a substitute, then there will be very little choice but to provide large quantities of kerosene and butane to the consumer, particularly the urban consumer. The impact on the nation's balance of payments is not an attractive prospect.

3. Quantifying the Possible Changes

Assessments have been made of how much each of the above new strategies could achieve, and by when. These are the best estimates available at this time as to what could be achieved with the right implementation plans, full cooperation amongst the various groups, proper organization and adequate funds. Figure 3-1 shows the effect in terms of a slowdown of depletion of the inventory of standing wood in all the northern part of the Sudan. The basic graph repeats the one in Chapter II. It shows that with current practices, if they continue unchanged, a very severe

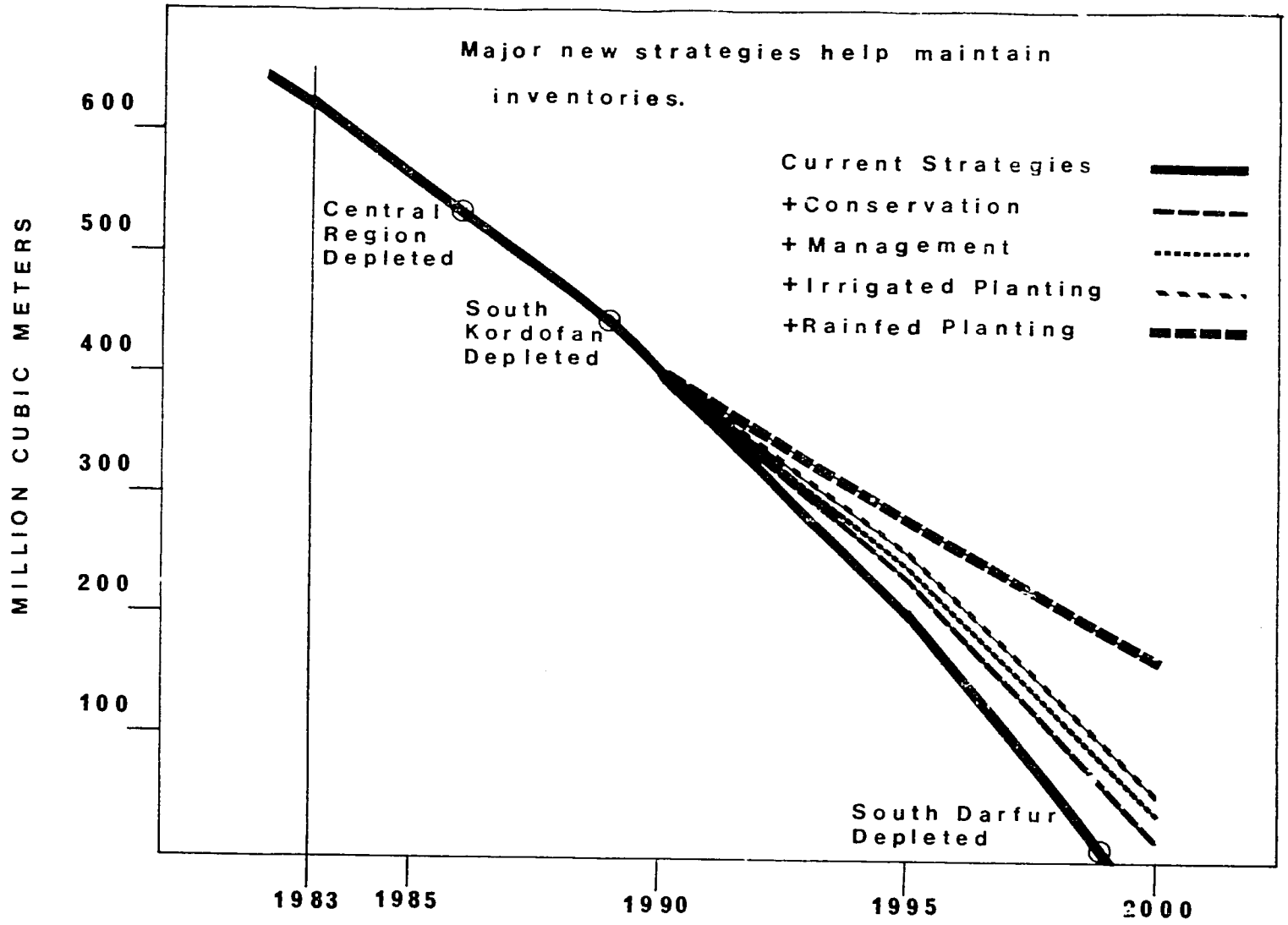


FIGURE 3-1. TREE INVENTORY.

problem will occur within ten years. This is not long when one considers how long it takes to grow a tree. This problem will be felt most directly when the forests of central Sudan and then southern Kordofan are eliminated and prices rise dramatically.

The effect of the new strategies as shown on the graph is based on the assumed achievements below:

a. 5% of irrigated land will be converted to grow trees.

b. Planting of new forests on existing bare rainfed land will average 1.7 million feddans per year for the foreseeable future.

c. Productivity of the existing forests will increase 25% and end use efficiencies will improve, especially via better charcoal stoves, so that within five years the demand will be 16% lower than currently projected.

It can be seen that even with major changes in management practices the decline of the forests will continue. This does not mean that exhaustion of forest cover in all of northern Sudan is inevitable. It does mean, though, that slowing down the decline to an acceptable rate is not going to be easy. The assumptions on which the graph is based are thought to be reasonable. However, not enough is known at the present time to judge their accuracy. The best that can be said is that major

changes have to be made very soon to have any chance of success. It takes a long time to grow a tree; time that can never be made up, if lost now.

The cost of carrying out these changes has been very roughly estimated to total about 1 billion LS over the next 15 years. This is not an enormous amount of money when you consider that it will introduce the radical change required and represents only 0.5 LS for every sack of charcoal consumed during this period.

4. Conclusions

It is reasonable to conclude, in a very broad sense, that the Sudan is capable of slowing the decline of its forests and retaining the widespread use of wood and charcoal as a fuel and, of course, wood for many other purposes. However, it is also reasonable to conclude that there does not seem to be a way to stop the steady decline in the availability of wood and the steady increase in its cost. The best that could be achieved would be to slow down the pace of decline and intensify reforestation in years to come.

D. RENEWABLES OTHER THAN WOOD FUELS

1. Overall Demand/Supply Objectives

a. Problems

The objectives are derived from the problems to be solved. For renewables to contribute to Sudan's energy supply, the problem is to:

1) Utilize economically the huge untapped resources of solar, wind, hydro and geothermal.

2) Utilize more efficiently the huge traditional renewable resources of agricultural residues, animal and human wastes.

b. Objectives

1) Supply

The main objective is to develop an economic use for these resources through economic applications. This objective is to be pursued with special emphasis on biomass.

2) Demand

Renewables are to be used to satisfy already met needs and therefore to substitute for:

* Oil and electricity in the Modern Sector thus saving foreign exchange and promoting exports of exportable energy resources.
* Wood and charcoal to stop the depletion of forests and the deterioration of the environment.

Renewables are to satisfy urgent unmet demand in rural areas through modern applications, e.g., water pumping, photovoltaic applications in health services, educational TV and remote telecommunication stations.

2. Strategy

a. Elements

1) Emphasize proven technologies and applied research aiming at local manufacturing and assembly because of the scarcity of capital and qualified manpower.

2) Use nontraditional and energy saving forms of biomass.

3) Apply in remote areas especially rural application of simple technologies.

4) Emphasize manufacturing and importing by the Private Sector.

5) Employ a promotion strategy to develop applications to the point where further applications and development can be sustained by the Private Sector.

b. Constraints

The new renewable technologies are still developing technologies. Therefore, their economic and technical parameters are continuously changing which makes planning and implementation difficult.

Reneweble applications in general are location and site specific. Therefore, the appropriate choice of technologies and designs and subsequent adaptations of these technologies have to be site and location specific. Also, if energy is needed on a different site, transportation economics come into play.

Biomass as the most important renewable source has competitive uses in a complex traditional society. New renewables have a relatively high capital cost and hence a relatively high initial cost per unit of energy output. Therefore, before initiating any program thorough studies should be carried out aimed at:

1) Assessing social acceptability. This may dictate or prohibit certain types of renewables.

2) Screening technologies and collecting information based on the experience of other countries. Technical information exchange programs are essential, especially with other developing countries with experience in this field (Egypt, Kenya, China, India, Philippines, etc.).

3) Establishing a comprehensive data base of the renewable resources and their current competitive uses in the regions to define the different potential energy end uses and users' groups.

4) Defining region-specific technical, economic, socioeconomic, ecological and sociocultural criteria for the application of the different systems.

CHAPTER IV

PLANS FOR CHANGE: POLICIES, PROGRAMS AND PROJECTS

The strategies presented in Chapter III provide the foundation for defining a plan of action - policies, programs and projects to achieve change - in each sector. These are developed below with specific reference to the institutions responsible for implementing each element of the program.* Then in Chapter V these implementation issues are more fully discussed.

* The action programs and project investment requirements are presented in tabular form in Appendix 1.

PETROLEUM

The strategies presented in Part 1 of Chapter III provide a framework and a set of directions for organizing the petroleum side of the Energy Sector. However, follow-up actions deriving from these strategies must be taken in order to achieve results.

A. POLICIES

One such follow-up is to establish decisionmaking policy guidelines, which not only communicate the intent of the strategies in issuing directives for specific action, but also identify the unit (or units) responsible for carrying out the required action.

These guidelines are covered in this section. They are grouped into three categories: demand management, supply continuity and supply increases. Subsequently, specific plans and projects will be identified.

1. Demand Management Policies

   a. Develop overall and sectoral demand growth targets to guide planning, operational and investment decisionmaking. These are to be based on national priorities for sectoral economic growth and to aim for balanced demand/supply by 1990, or earlier.

      Responsibility: GPC assisted by NEA.

b. Institute a product pricing system to discourage nonessential use in favour of higher priority economic use.

Responsibility: GPC/NEA with Ministry of Finance and Economic Planning.

c. Restrict and/or tax nonessential imports of oil-consuming equipment and establish technical standards.

Responsibility: GPC/NEA with appropriate Ministries.

d. Educate consumers to conserve oil by providing information and technical advice both to the general public and directly to large, individual consumers.

Responsibility: NEA/ERC.

e. Emphasize expansion of hydro power electricity generation in planning and in requests for financial support.

Responsibility: NEC.

f. Assist industry to expand the use of crop residues and other indigenous resources to replace oil.

Responsibility: NEA/ERC.

2. <u>Supply Continuity Policies</u>

Create a system whereby sufficient foreign exchange on a continuous basis for oil purchases will be guaranteed. This system is to be coordinated with contributions from foreign donors as part of the Petroleum Financing Facility.

Responsibility: GPC/Bank of Sudan/Ministry of Finance and Economic Planning.

3. Supply Increase Policies

a. Promote the introduction of appropriate technologies and overcome problems impeding such innovations (production, information, conservation, standardization).

Responsibility: NEA/NCR

b. Investigate projects for use of noncommercial western crude and Red Sea gas discoveries to replace oil imports; if economic, develop financing.

Responsibility: NEA/NEC/GPC

B. PROGRAMS AND PROJECTS

Consideration has been given to the facilities required to deliver petroleum products to consumers in both the near term (1985-1990) and long term (1991-2000).

1. Assumptions

As a first step, several key assumptions were made:

a. Foreign exchange will be available to double petroleum product consumption from 1984 to 1990 (1.1 to 2.0 million tons/year), and increase three times (to 3.1 million tons) by 2000.

b. Crude exports will begin in 1987.

2. Projects

Based on these assumptions, the following investments have been identified:

Table 4-1

PETROLEUM SECTOR INVESTMENT PROGRAM

	1985-1990 (MM $)	1990-2000 (MM $)
Refining:		
Port Sudan Rehabilitation	7	18
New Inland Refinery	84	650
Pipeline:	16	
Storage:	15	
Blending:	10	
	132	668

3. Implementation

a. Near Term (1985-1990)

The Port Sudan minor improvement project is justified based on fuel savings and continuity of operations. The decision to proceed with the new refining investment ("mini-refinery") will be tied directly to the completion of the proposed crude export pipeline and fuel supply requirements of new thermal power stations.

b. Longer Term (1991-2000)

The forecast refinery investments are based on strong demand growth forecasts. Further understanding will be gained before investment decisions are made.

ELECTRICITY

Chapter III, Part 2 defined a four part strategy to overcome problems in the Electricity Sector.

A comprehensive mix of policies, programs of action and capacity expansion plans will successfully realize implementation of that strategy. These are presented below.

A. EFFICIENCY IMPROVEMENTS AND DEBOTTLENECKING

1. Debottlenecking

The first action required in the Electricity Sector is to eliminate the bottlenecks presently constraining performance. The recommendations of the Subcommittee on Electricity Sector Bottlenecks are summarized below:

* Make foreign exchange available for regular and timely purchases of spare parts.
* Accelerate the rehabilitation of Burri power station to provide adequate electricity for the coming hydro-constrained year.
* Replace or upgrade transformers connecting power stations to the grid to increase delivered electricity and improve the ability of the grids to handle variations in load.
* Install new substations and upgrade existing ones at selected points in the BNG to reduce losses and increase reliability.

* String a third 220 KV circuit from Roseires to Sennar station to increase reliability.
* Upgrade capacitors on long lines to reduce losses.
* Provide adequate training and incentives to attract and retain qualified personnel to maintain the BNG and isolated systems.
* Support NEC with required logistics.
* Continue the dredging at Roseires to maximize hydro output. Institute a program to manage the Roseires resevoir basin to minimize debris accumulation.

In most cases, a moderate investment of effort yields a substantial improvement or energy gain. However, one issue looms above all others in its significance as an obstacle to improved performance: transport of heavy fuel oil to thermal power stations.

By mid-1985 with the completion of the Power III project, requirements for the transport of fuel oil from Port Sudan to Khartoum will surge from 440 to 840 MT per day, an increase of 90%. Sudan railways currently can only deliver 200 MT/day. The outlook for improvement in their capacity is limited.

Immediate action is obviously required here. A task force representing GPC, NEC and the Ministry of Transport is currently studying this problem (see Petroleum Debottlenecking Subcommittee Report). Note that the realization of an inland mini-refinery represents a practical solution over the long run, easing the problem and providing available fuel.

2. Technical Losses

A program to reduce transmission and distribution losses from the current 16-20% to 10-12% in five years is to be implemented by the NEC. This could save approximately 94 GWH in 1987/88 and reduce generation capacity required at peak by 4%. The NEC has begun this effort but a specific action program is required as part of the Plan. Recurrent donor funds are to be targeted for this effort.

3. Conservation and Efficiency in Consumption

The current efforts underway at the NEC to launch conservation and efficiency programs to reduce electricity consumption represent an encouraging first step towards greater efficiency. These programs must now be focused and expanded. The key elements are:

a. Proper Billing.

Unpaid and unbilled consumption, ranging from 16-20% of generation, is to be eliminated in three years. This will add approximately 30-35 million LS to NEC revenues and promote conservation among users who now enjoy virtually free electricity. Overall electricity consumption could be reduced by 1.5% with this reform. NEC is launching this effort by upgrading their data base, replacing broken meters, registering customers and computerizing the billing system. A comprehensive management approach to this problem is recommended.

b. Inverted Block Rates for Residential Consumers

The present inverted block rates, where additional KWH cost more than earlier ones, are a very positive aspect of the present tariff structure. To promote conservation and discourage extravagent consumption, a steeper rate differential is recommended. For example, the first 100 KWH could be priced at 10 pt. (equivalent to today's rate), the next 100 at 20 pt. and all additional KWH priced at 40 pt.

This system will allow middle and low income users to consume the energy they need for basic living at reasonable prices, but will force heavy users to pay dearly (those who use air conditioners or who waste electricity). Conservation savings could amount to 1% of total consumption. This issue is to be addressed in a forthcoming NEC rate study.

c. On Peak and Off Peak Rates for Large Customers

On peak and off peak rates are to be implemented on a selective but mandatory basis for large commercial, industrial and agricultural users. Higher prices for peak period consumption (daily and seasonally) will encourage customers to use less energy in these critical times. On peak and off peak rates are currently available to large users, but only in effect for a minimal number. This program is to be expanded by NEC.

d. Electricity Conservation.

A comprehensive program to reduce unnecessary electricity consumption in all sectors is to be developed and implemented by

the NEC and the NEA. For the Government Sector, efforts recently launched to limit usage are to be continued and expanded. These include recruiting monitors for all public buildings and reducing streetlighting at times of shortage. The NEA is to work with the NEC to launch a program of audits identifying ways large users such as the Industrial Sector can economically limit consumption without reducing output. A general public awareness campaign is to be introduced in the Residential and Commercial Sectors including an education program at schools.

An aggressive campaign could reduce overall consumption by about 3% in a few years, with a target of a 5% reduction for the Industrial and Commercial Sectors, as a result of conservation combined with on peak and off peak rates. The target for Government Sector savings is 10% over three years.

4. Summary: Energy Savings

Potential savings from implementing these conservation and efficiency measures are summarized in Table 4-2. Note that over half of the savings come from meeting the target to reduce technical losses to 12%.

These must be considered as "best guesses" in quantifying the effects of a vigorous program to reduce losses and promote efficiency. Such savings could potentially be realized in as little as three years thereby providing more energy to satisfy future demand.

The NEC and the NEA are to analyze these programs in more detail to develop a more accurate assessment of possible savings for use in power system planning.

Table 4-2

POTENTIAL ENERGY + DEMAND SAVINGS IN THREE YEARS FROM EFFICIENCY AND CONSERVATION PROGRAMS

	Savings (%)	Annual Generation (GWH)	Peak Reduction (MW)
Reduction in technical losses from 16 to 12%	5.2	94.0	18.0
Implementation of steep inverted block rates for residential users	1.0	18.0	3.5
Government Sector conservation and reduced streetlighting	.3	6.0	1.0
Industrial and commercial conservation	2.2	41.0	7.6
Collection of unbilled consumption	1.1	20.0	3.8
TOTAL Savings	9.8	179.0	33.9

B. MANAGEMENT OF DEMAND GROWTH

The above section identifies means to realize energy savings in the existing patterns of distribution and consumption to make available more energy to the economy. Implementing these programs is the first step in eliminating unnecessary consumption.

The second step is to plan how to manage the growth in demand and the timing of future consumption. By managing future demand the Energy Sector will be able to avoid the unscheduled

power cuts and unreliability that plague the system today. The program of action to be implemented by the NEC in cooperation with the NEA is outlined as follows.

1. Control Growth in Demand

* Define targets for yearly demand growth so that increases in consumption match expansion in supply. Define targets and set priorities for sectoral demand growth.
* Conduct a detailed study of demand and consumption to identify where increases in demand come from and what relationship these demands have to economic growth.
* Set priorities for expansion of services based on economic criteria. Work jointly with other concerned ministries in analyzing needs and establishing priorities.
* Work with the Ministry of Finance and Economic Planning (MFEP) to incorporate constraints on availability of electricity into the National Economic Plan.
* Establish standards for efficiency, power factor and energy consumption on all electrical equipment, imported or manufactured. Work with related ministries to implement these standards as enforceable regulations.

* Use prices and other economic tools to manage demand growth.

  a. Implement steeper "inverted block" rates to discourage residential consumption of excessive amounts of energy and use of energy consuming appliances.

  b. Tax the purchase of energy intensive appliances: air conditioners, freezers, heavy duty refrigerators, electric stoves, microwave ovens and others.

2. <u>Control Timing of Consumption to Reduce Energy Consumption and KW Demand at Peak Periods:</u>

* Use rate surcharges and incentives to shift varieble demand to off peak periods on a daily and seasonal basis.

* Implement on peak and off peak rates for larger commerciel, industrial and agricultural users. Charge those users according to the real economic cost of providing service.

* Where feasible, connect large private generating units into the grid for optimal use of available power resources. Incorporate such connected capacity as well as standby units into system planning as emergency capacity for peak daily and monthly periods.

* Develop and, when economically feasible, implement load management programs for direct control of customer appliances (e.g., devices to cycle air conditioning in large buildings).

These measures to control demand growth and the timing of consumption will enable the NEC to match demand with available supply on a planned (rather than the current unplannad) basis. Thus the NEC will be able to increase system reliability and minimize economic losses resulting from energy shortages. Such an approach is extremely important if financial constraints lead to delays in implementing the new projects outlined in Section C, below.

C. CAPACITY EXPANSION PLAN

The capacity expansion plan of the BNG to meet the 7.5% growth rate forecast and provide very high reliability is presented in Table 4-3. The key elements of this plan are:

1. Near Term - Thermal Supplemented by Hydro.
   - 65 MW of gas turbine and diesel over the next three years.
   - 120 MW steam in 1987-1990.
   - 70 MW hydro before 1990.
2. Long Term - Hydro.
   - Commissioning of lower Merowe in the early 90s.
   - Heightening of Roseires Dam.
   - Construction of Upper Atbara Project (Setiat)
   - Subsequent development of other Merowe dams.

Table 4-3

BLUE NILE GRID EXPANSION PLAN: 1985-2000

Generation

Near Term (1985-1990)

1985	60 MW	2x30	Power III
1986	30 MW	2x15	Gas Turbine
	18 MW		Rehabilitation (Burri Steam)
1987	40 MW		Roseires #7 Hydro
	20 MW	2x10	Burri Diesel Extention
	15 MW	3x5	Eastern Grid Diesels
1988	60 MW	2x30	Khartoum North 1, 2
1989	30 MW	1x30	Khartoum North 3
	30 MW	4x7.5	Sennar II Hydro
	5 MW	1x5	Eastern Grid Diesels
1990	30 MW	1x30	Khartoum North 4
	300 MW	6x50	Hamdab Hydro

Total Near Term: 638 MW

Long Term (1991-2000)

300 MW	Birti Hydro
300 MW	Shirri Hydro
150 MW	Thermal

Total Long Term: 750 MW

TOTAL: 1,388 MW

Transmission Lines

220 KV	230 KM
110 KV	330 KM
64 KV	90 KM

D. REGIONAL ELECTRIFICATION

The long range goal for the regions is to expand the existing small systems and electrify 55 new urban centres. Small grids and interconnections are to be considered whenever economically feasible.

Realizing this goal is, however, constrained by a lack of finence, limited management and technical skills, and the limited ability of regions to afford the high cost of electricity and fuel inputs. Indeed, the situation now in the regions is troubled as the Governments' have assumed responsibility for systems which operate inefficiently, require spare parts and expertise to upgrade, and, given current costs and rate structures, are resulting in huge deficits. This financial burden is straining the capabilities of the newly established regional governments.

Given these constraints and current problems, the proposed near term program is:

1. Consolidate and upgrade existing systems, developing management and technical capabilities to operate efficiently.
2. Expand service selectively in all regions based on the criteria of equity across regions and ability of towns to afford the electricity.

To realize this program the Private Sector must be involved to the greatest extent possible. The financial and management resources of private interests can go a long way towards

resolving the current problems and providing the basis for long term reliable and affordable power. One approach is to establish privately owned or cooperative corporations. Another is to contract out the management and operating responsibility to a private concern.

Under any ownership structure the principle must be to provide electric service without subsidies. While deficits may be justified in the short term, reliable electricity on a sustainable basis can only be provided if the corporate entity operates on a sound financial basis. Otherwise, the system will be chronically short of cash and shortages of fuel and spare parts resulting in high unreliability will follow.

Finally, developing the regional electricity system requires relying to the maximum extent on local resources, e.g., small hydro, remote crude deposits, and eventually other resources such as solar and wind.

Responsibility for achieving this program rests primarily with the Regional Governments. The NEC and NEA are to assist in technical, planning and management aspects.

E. IMPLEMENTATION

The proposed investment program to implement the above strategies is $3.8 billion from 1985-2000. $3.0 billion is dedicated to the Blue Nile and Eastern Grids while the remaining $1.8 billion is for investments to meet NEP targets for isolated systems and the development of new urban centres. $1.5 billion of this total is required in the near term (1985-1990).

Table 4-4 provides the details on these investments. Clearly this program is ambitious. If successful, it will provide a system with capacity to meet all contingencies through the end of the century.

Table 4-4
ELECTRICITY SECTOR INVESTMENT PROGRAMS
NO FINANCIAL CONSTRAINTS
Near Term (1985-1990)

	Foreign Component (MM$)	Local Component (MM LS)	Total (MM $)
Blue Nile and Eastern Grids			
Debottlenecking*	30.0	5.0	33.8
Rehabilitation	42.2	5.0	46.0
Generation			
Thermal	181.5	50.0	220.0
Hydro	405.8	99.0	482.0
Transmission + Distribution	196.0	130.0	296.0
Fuel Transport	38.0	-	38.0
Studies	8.2	1.0	9.0
Total Grids	901.7	290.0	1,124.0
Isolated Systems			
Debottlenecking*	20.0	5.0	23.8
Generation	154.4	45.0	190.0
Transmission + Distribution	52.8	25.0	72.0
New Urban centres	94.7	55.0	137.0
Total Isolated Systems	321.9	130.0	422.8
Total Near Term	1,223.6	420.0	1,547.6
Long Term (1991-2000)			
Blue Nile and Eastern Grids			
Generation			
Hydro	870.5	180.0	1,009.0
Thermal	146.1	35.0	175.0
Transmission + Distribution	261.5	50.0	300.0
Total Grids	1280.1	265.0	1,484.0
Isolated Systems			
Generation	364.5	50.0	385.0
Transmission + Distribution	203.1	35.0	230.0
New Urban Centres	127.3	75.0	185.0
Total Isolated Systems	694.9	160.0	800.0
Total Long Term	1,957.0	425.0	2,284.0
TOTAL LONG + NEAR TERM	3,190.6	845.0	3,831.0

* Partial estimate, excludes certain items not quantified in Subcommittee Report.

WOOD FUELS

A. ACHIEVING CHANGE

The major thrust of the strategies for wood fuels defined in Chapter III, Section C was on the need for change. This section discusses policies and programs to realize those strategies.

First, what are the possibilities of achieving changes? There are many hurdles to reaching the goals. The major ones are:

1. Society is indifferent to the problem, and not yet ready to support a solution.
2. Competition for the land among agriculture, livestock grazing and trees, if not resolved, could prevent implementing any significant program.
3. Many governmental units and other institutions could continue to pursue their own goals, making a coordinated effort ineffective.
4. Funds could not be found, from the government budget and from oversees donors, to carry out the size of the effort required.

But there are some favorable signs that give hope:

* Interest in tackling the problem is increasing at the highest political levels, Notably, the keynote speech by the President at the recent Forestry conference, the efforts underway in the West to lessen the effects of drought, and the ongoing coordinated donor assessment project.

B. THE NEXT STEP

The National Energy Plan has mainly looked at the wood/charcoal situation as an energy problem. Obviously it is much more. It is many problems: rural development, agricultural production, land use, and the environment. Therefore, when considering the next development step for energy, it must be done in conjunction with whatever development steps Sudan wishes to follow in all of these other areas.

It would not be effective for the Energy Sector to develop and promote specific plans on wood and charcoal that relate only to energy. However, the Energy Sector has a major responsibility to contribute to resolution of this unsatisfactory wood/charcoal outlook. In the light of the importance of energy, then, the Energy Sector should take the initiative to see that a broad coordinated national effort is started.

C. RECOMMENDATIONS

The major recommendations then are:

1. Promote the formation of a high level commission representing all of the constituencies concerned with this problem to reach a national consensus on action. One of the key starting points for its consideration would be the full report prepared under the National Energy Plan.

2. Take the initiative to obtain information and analyses to better understand the entire wood fuel/charcoal supply and consumption system. Such a data base would be imperative for any serious full-scale effort to solve the problem.
3. Plant wood fuel trees within the framework of an overall integrated reforestation policy, so that the cutting of one type of tree does not take place at the expense of other types.
4. Seek opportunities to support specific projects to increase the competitive supply of wood/charcoal, especially to encourage development of private investment.

D. PROJECT INVESTMENTS

Tables 4-5 and 4-6 summarize the projects and investments proposed to implement these strategies and recommendations. A total of $844.1 MM will be required over the life of the Plan, with $281 MM needed in the next five years.

Table 4-5

WOOD FUELS INVESTMENT PROGRAM

Near Term (1985-1990)

Project	MM LS
Development of Forest Resource	
Reforestation	
Planting 1.7 million Feddan Annually on Rainfed Areas	233.0
Planting a Total of 80,000 Feddans Irrigated (5% of irrigated schemes)	11.5
Subtotal	244.5
Resource Management	
Inventory	20.0
Reservation	40.0
Rehabilation of Reserves	20.0
Protection	20.0
Subtotal	100.0
Conservation and Demand Management	
Improved Stove (Design and Dissemination)	1.9
Improved Technology in Other Nonhousehold Uses	0.8
Demand Management Education Campaign	0.8
Subtotal	3.5
Institutional Support, Strengthening Planning Capabilities, Regional/Central	2.8
Manpower Training (0.5% of investment)	2.0
Research and Development (3% of the total investment)	12.8
TOTAL	365.6

Table 4-6

WOOD FUELS INVESTMENT PROGRAM

Long Term (1991-2000)

Project	MM LS
Development of Forest Resource	
Reforestation	
Planting 1.7 Million Feddan Annually on Rainfed Areas	467.0
Planting a Total of 80000 Feddan Irrigated (5% of irrigated schemes)	22.5
Subtotal	489.5
Resource Management	
Inventory	40.0
Reservation	80.0
Rehabilitation of Reserves	40.0
Protection	40.0
Subtotal	200.0
Conservation and Demand Management:	
Improved Stove (Design and Dissemination)	3.7
Improved Technology in Other Nonhousehold Uses	1.6
Demand Management Eduaction Campaign	1.6
Subtotal	6.9
Institutional Support Strengthening Planning Capabilities Regional/Central	5.6
Manpower Training (0.5% of Investment)	4.0
Research and Development (3% of the total investment)	25.6
TOTAL	731.6

RENEWABLES (EXCLUDING WOOD/CHARCOAL)

The policies, projects and plans that follow the strategies described in Chapter III, Section D are set forth below.

A. POLICIES

1. Institutional Measures

a. Strengthen the National Renewable Energy Research Institutions & raise their outreach capability.

Responsibility: NCR, MEM.

b. Because of the site specific character of renewables, regions are to work out their own region specific renewable plans and programs.

Responsibility: Regions, NEA, ERC/RERI.

c. Include strong renewable departments in the Regional Energy offices which are planned to be established.

Responsibility: Regions, NEA, ERC.

d. Encourage multidisciplinary and cross-institutional cooperation among public, private & other institutions.

Responsibility: NEA, ERC, Industrial Association, Farmers' Union, Professionals' Unions (engineers, agriculturalists, foresters, veterinarians), Regions.

2. Technology Development

a. Strengthen the research and development program.

Responsibility: ERC/RERI/Universities.

b. Institute a technical information exchange program.

Responsibility: NEA, ERC, Unions, Vocational Training Centers, Foreign Donors.

c. Develop a standard specification system.

Responsibility: NEA, ERC, Unions, Ministry of Industry, Ministry of Commerce.

3. Economic Measures

a. Exempt renewable systems from import and production taxes.

Responsibility: NEA, ERC, MFEP.

b. Establish renewables energy credit facilities programs for manufacturers, users and importers.

Responsibility: NEA/ERC, Central Bank, Commercial and Development Bank, MFEP.

c. Establish sales promotion funds for manufacturers.

Responsibility: NEA, Public Institutions, Unions.

d. Secure attractive weges and salaries for engineers, technicians and other professionals involved in renewable activities.

Responsibility: NEA, MFEP, Unions.

4. <u>Education, Demonstration, Extension</u>

a. Develop a public awareness campaign.

Responsibility: NEA, ERC, Unions.

b. Integrate renewable studies into curricula of educational institutions, especially technical vocational centres (TVC).

Responsibility: NEA, ERC, TVC, Artisan's Union.

c. Establish renewables promotion centers with demonstration exhibitions & extension training programs.

Responsibility: NEA, ERC, Regions, TVC.

d. Integrate some of renewables promotion centers into educational systems.

Responsibility: NEA, ERC, TVC.

B. PROJECTS AND PLANS

A Renewables Promotion Program has been prepared and details of the steps and near-term investment required are presented in Table 4-7. The underlying concept of this action program is to develop renewable technologies to the point where further development and research can be sustained by the Private Sector. The Renewables Task Force (see Section C) is then to design the detailed plan to implement the program guided by the availability of resources, and the strategies, policies and priorities set forth in the Plan.

Table 4-7

RENEWABLES (EXCLUDING WOOD FUELS) INVESTMENT PROGRAM

Short Term 1985-1990
In MM LS

Resource and Technology	Activities	1985	1986	1987	1988	1989	1990	Total
Solar	Prefeasibility Study	81.0	-	-	-	-	-	81.0
	Development & Adaptation	75.6	-	-	-	-	-	75.6
	Field Test & Pilot Project	275.3	26.2	-	-	-	-	301.5
	Feasibility Study	64.2	18.0	-	-	-	-	82.2
	Demonstration & Dissemination	46.1	884.2	45.6	-	-	-	975.9
	Local Manufacturing	-	60.0	120.0	-	-	-	180.0
	Importation	-	-	24.0	-	-	-	24.0
Subtotal		542.2	988.4	189.6	-	-	-	1,720.2
Passive Cooling	Prefeasibility Study	44.4	-	-	-	-	-	44.4
	Development & Adaptation	219.8	33.1	-	-	-	-	252.9
	Field Test & Pilot Project	-	205.2	-	-	-	-	205.2
	Feasibility Study	-	27.8	12.0	-	-	-	39.8
	Demonstration & Dissemination	-	-	236.4	8.4	-	-	244.8
	Local Manufacturing	-	-	-	-	-	-	-
	Importation	-	-	-	-	-	-	-
Subtotal		264.2	265.9	248.4	8.4	-	-	786.8
Wind	Prefeasibility Study	54.0	-	-	-	-	-	54.0
	Development & Adaptation	219.5	130.3	27.7	-	-	-	377.5
	Field Test & Pilot Project	-	36.8	63.1	8.3	-	-	108.2
	Feasibility Study	-	-	27.0	27.0	-	-	54.0
	Demonstration & Dissemination	-	-	265.4	606.0	320.5	111.6	1,303.5
	Local Manufacturing	-	-	-	-	120.0	180.0	300.0
	Importation	-	-	-	-	-	-	-
Subtotal		273.5	167.1	383.2	641.3	440.5	291.6	2,197.2
Mini-hydro	Mini-Hydro Studies	180.0	180.0	180.0	180.0	180.0	180.0	1,080.0
Biogas	Prefeasibility Study	30.0	-	-	-	-	-	30.0
	Development & Adaptation	70.3	-	-	-	-	-	70.3
	Field Test & Pilot Project	77.5	-	-	-	-	-	77.5
	Feasibility Study	-	24.0	-	-	-	-	24.0
	Demonstration & Dissemination	-	262.8	-	-	-	-	262.8
	Local Manufacturing	-	120.0	-	-	-	-	120.0
	Importation	-	-	-	-	-	-	-
Subtotal		177.8	406.8	-	-	-	-	584.6
Briquetting	Prefeasibility Study	12.0	-	-	-	-	-	12.0
	Development & Adaptation	88.5	-	-	-	-	-	88.5
	Field Test & Pilot Project	9.8	-	-	-	-	-	9.8
	Feasibility Study	12.0	-	-	-	-	-	12.0
	Demonstration & Dissemination	-	80.7	-	-	-	-	80.7
	Local Manufacturing	-	240.0	-	-	-	-	240.0
	Importation	-	-	-	-	-	-	-
Subtotal		100.1	330.7	-	-	-	-	430.8
Gasification	Prefeasibility Study	21.8	-	-	-	-	-	21.8
	Development & Adaptation	439.4	-	-	-	-	-	439.4
	Field Test & Pilot Project	53.8	14.9	-	-	-	-	68.7
	Feasibility Study	-	28.8	-	-	-	-	28.8
	Demonstration & Dissemination	-	1,719.6		-	-	-	1,719.6
	Importation	-	-	12.0	-	-	-	12.0
Subtotal		514.8	1,763.3	12.0	-	-	-	2,290.1
TOTAL		2,052.6	4,102.2	1,013.2	829.7	820.5	471.6	9,089.8

Investments in the short term = LS 9,089.8

35% of this total is to be allotted for the renewables Promotion Center = LS 3,181.4

30% of labor budget to be allotted to unskilled labor = LS 543.4

TOTAL 12,814.3

Best Available Document

C. IMPLEMENTATION

A complex, and costly, series of steps has been described to meet the objective of either commercializing each major renewable technology or determining that commercialization is not feasible. These steps include: research, studies, pilot projects, market development, and others. The overall cost has been estimated at 13 Million LS.

In order to effectively carry out such a large and complicated program, a great deal of decisionmaking, fund raising and coordination - in other words, management - will be required. At the present time, there is no organizational framework in place, fully-staffed, and functioning smoothly, to handle this task. An appropriate organization needs to be created, or else it is unlikely that the objectives will be met.

Proposal

The successful effort by the Renewable Subcommittee of the NEP to produce the commercialization plans, suggests a similar approach to manage the implementation. Although committees are not usually the best instrument for management, in this case there is no ready alternative. With the right terms of reference, and the right membership, such an approach should be successful.

Specifically, it is proposed that:

1. Implementation be put in the hands of the Renewables Implementation Task Force. It would report directly to the Minister of Energy and Chairman of the National Council for Research, with an obligation to seek guidance and advice from the National Energy Research Council.

2. The purpose of the Task Force is to carry out the NEP program in renewables through existing organizations, by providing overall guidance, management, organization, fundraising and disbursement. This Task Force would exist for one year, subject to renewal if it can continue to serve a useful purpose.

3. The Task Force be chaired by an appointee of the Minister of Energy, have permanent representatives from NEA and RERI, and have the support of the AID Energy Planning and Management Project. Other members would be added, as appropriate, especially to further the commercialization objective.

4. The Task Force be required to develop, disseminate and maintain workable technology forward to either each renewable technology forward to either a self-sustaining commercialization status, or else agreement to stop at some prior step because of unsatisfactory prospects.

5. The Task Force be required to develop the funding needed to carry out the plans either directly or through other organizations that are participating in various phases.

CHAPTER V

IMPLEMENTATION OF THE PLAN

Chapters III and IV defined the fundamental strategies and key projects, policies, and programs that form the core of this first National Energy Plan. Now the job of implementation -- making change happen -- must begin. This requires efficient management within the Energy Sector, coordinated action at all levels of Government and finance. In addition, successful implementation involves strengthening capabilities in research and development, information systems, and in institutionalizing the planning process. Finally, follow up is essential to ensure that the plans set forth are acted upon.

A. ORGANIZATION AND MANAGEMENT

1. Within the Energy Sector

Execution of the Plan requires effectively functioning institutions and offices with clearly defined mandates, adequate resources, a trained and accountable staff, and incentives for efficiency in operations. Without such a proper institutional framework and process, it will be difficult to realize the Plan objectives. All these areas could be improved. Thus, the Plan recommends the following:

a. Form a Ministerial Task Force to review the organization of the Ministry and recommend changes, if appropriate. In line with the Minister's directives, it is

recommended that this committee be formed right away after acceptance of the Plan and report to the Minister within three months.

The charge of this task force is to:

* Review decrees and charters of corporations, agencies and offices.
* Identify areas of overlapping responsibilities and recommend changes, if needed.
* Recommend ways to better coordinate the Energy Sector through the formation of a Higher Energy Council.

The issues and suggestions presented in the NEP Organizational Report are to serve as guidelines.

b. Form a Higher Energy Council consisting of the Directors of all energy-related corporations and administrations. The specific duties and responsibilities of this council are to be defined by the special task force, above, but generally this body is to advise the Ministry on all major issues and coordinate overall planning and implementation of key decisions.

c. Review Staffing Levels and Terms of Service for all corporations and agencies. Inefficiency results from so many people doing little work for little money. The Plan recommends a review of staffing requirements and appropriate compensation required to effectively carry out the responsibilities of each organization and agency. The goal is to operate with an efficient, highly qual fied staff, providing compensation to

realize higher productivity and reduce brain drain. This review is to be undertaken by the Ministry and the Higher Energy Council.

d. Strengthen Training and Career Development for managers and technical staff. Each corporation and administration is responsible for developing its own program. The Ministry will institute a sectorwide energy management training program. Facilities developed can in the future be extended to those outside the Energy Sector for broader benefits of this initiative.

e. Eliminate Subsidies of Energy Operations. Develop a program to realize the goal of operating the corporations - NEC and GPC - without subsidies. They should be self-financing ongoing operations with the authority to establish tariffs at the level required to earn a fair rate of return. Each corporation is to develop its own program for submission to the Higher Energy Council for review and approval.

2. At the Regional Level

The logistics of Sudan, the difference in habits and modes of life, the richness of regions in local resources, and the fact that the majority of the poor population lives in remote areas, mandates the development of regional energy programs. These are designed to solve the energy problems of the poor, create stability in the regions, reduce internal migration and create conditions for development.

Two factors will help the effort to succeed:

1. Political and administrative regionalization which localizes the decisionmaking process.
2. The difficulty centrel organizations like NEC and GPC experience in monitoring and supporting their regional operations.

Tha potential to influence the regional energy crisis, which consists of increasing shortages of wood fuels for households and scarce, costly commercial energy, is substantial. Change for the better has major ecological, economic, and social repercussions.

The regional energy program should therefore concentrete on:

* Collecting regional information and developing regional energy balances.
* Initiating projects to develop regional energy resources using local technologies.
* Training of local manpower in energy manegement and technical operations.
* Conducting studies on households and the sociology of tribes relating to energy consumption and resource development.

Accordingly, the Plan recommends the following activities to develop the regions' capabilities to deal with their energy problems:

* From the national energy strategy, derive regional strategies depending on the demand and supply of each region.

  Responsibility: NEA

* Form organization links between regions and the central Ministry of Energy.

  Responsibility: NEA

* Carry out region-by-region assessments which include demand and supply. Identification and development of resources are to follow so that regional plans and projects can be identified using local resources.

  Responsibility: NEA

* Technical assistance from NEC to regions should continue so that regions can support their operations on a sustainable basis.

  Responsibility: NEC

3. <u>At the National Level</u>

Solving the energy problems of today and preparing for the future involves not just the Energy Ministry but coordination with other ministries and action at the national level. The key issues of developing sustainable wood fuel resources, exploiting the hydro potential of the Nile, and ensuring the timely execution of large energy projects all require different government institutions coming together and pursuing joint actions. Therefore, the Plan recommends formation of three high-level commissions to tackle these problems at the national level.

a. **A High-Level Commission on Forestry Resources.**

<u>Objective:</u> Mobilize the Nation to act on developing sustainable forestry resources.

The Plan calls for drastic, immediate action and a large investment of funds to protect Sudan's forestry resources. This issue, though, is not just an energy problem but involves consideration of needs for agriculture, grazing, housing and many other uses. The first step recommended in the Plan is development and then implementation of a comprehensive land use management plan, including an agressive reforestation program.

Such programs have been advocated for years, but no actions have resulted. This must change. The Plan's process must capture the attention of the Nation to mobilize the resources, and establish the organization and management systems needed to operate an aggressive program.

The High Level Commission is therefore charged with reviewing all aspects of the current problems and developing an overall approach to provide sustainable forestry resources adequate to meet needs over the long term. A major focus then must be on the organization and management structure and policy initiatives required to implement a workable program.

The Commission must represent all involved parties including those in the Regions. It is to issue a preliminary report within 12 months and a final action program in 18 months. Consultant support is to be provided and the donor community involved in the

effort. The Ministry of Agriculture with the Ministry of Energy is responsible. This effort is to be coordinated with the donor Forestry Assessment Project and the current activities to establish a High Council for Natural Resources.

b. **A Task Force on Development of Hydro Resources.** **<u>Objective:</u> Realize government consensus leading to action on a program to develop hydro resources to benefit Sudan in the 1990s.**

Hydro resources affect all aspects of the economy and involve many decisionmakers at all levels of government. Many proposals to develop hydro for the benefit of agriculture, energy, and regional development are now tabled. Definitive choices must soon be made so that real action, including securing financing, can begin.

The Task Force on Development of Hydro Resources is charged with analyzing all options and developing a viable hydro program. This committee is to report within six months. Consultant support is to be provided and the donor community involved in this effort. Responsibility for initiating this effort is with the Ministry of Energy working with the Ministry of Irrigation and the Ministry of Agriculture.

c. **A High-Level Steering Committee for Large Energy Projects.** **<u>Objective:</u> Coordinate across ministries to expedite project implementation.**

Major energy projects frequently are delayed due to a lack of coordination between various units of the government. These delays cause serious energy shortages and are costly. (See Section D below.) Therefore the NEP recommends creation of a high-level committee as needed to oversee construction of large projects involving coordination among ministries.

B. ACQUIRING FINANCE

Capital investment in the Energy Sector must increase to achieve the goals of the Plan and reverse present trends. The Plan calls for $2 billion of projects to be financed over the next 5 years and $3.5 billion in the 1990s.*

Of this initial $2 billion for the whole Energy Sector, only a small portion for power generation has been secured. This program is presented as the target required for a strong Energy Sector. A first task of implementation will be to establish priorities and devise strategies to secure minimum financing requirements and to avoid delays in implementation.

Clearly there is no easy way to raise this money given Sudan's huge debt burden and weak financial performance. Yet without such investment the economy will be continually crippled by inadequate energy supplies.

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* See Appendix 1 for the summary of the Projected Investment Program.

The Plan, therefore, recognizes the importance of self-financing within the Energy Sector ... that is, collecting revenues that exceed operating and depreciation costs, thereby creating a surplus to pay for future expansion. This approach will not only provide needed cash but also strengthen the ability of the Energy Sector, as part of the Government, to secure loans and grants.

This approach is effectively a major means of acquiring finance and must be coupled with efforts to secure grant monies or soft loans from donors. It means a reversal of the current situation where the Energy Sector is a net drain on the Treasury. Under such conditions it is impossible for Sudan to fund any major investments.

A complementary approach is to explore innovative sources of finance by involving the Private Sector as much as possible through creating special incentives for investment.

In addition, the Plan recommends the following:

1. Establish priorities at the Ministerial level for capital projects and development programs. This review of capital budgets -- the outcome of which is to advise the Minister -- is to be one of the functions of the Higher Energy Council. These priorities are to be established in the first year of the Plan.

2. Develop an effective strategy for securing the finance by dividing the total amount required by sectors', develop marketable packages, focusing efforts on the highest priority items, and avoiding competition from different units of the Ministry for funds from the same donor or financing source. This effort is to be coordinated by the Office of the Ministry.

C. IMPLEMENTATION OF PROJECTS

A cornerstone of this Plan is the series of projects (totelling $5.5 billion) identified in Chapter IV. Major as well as smaller projects are called for including Power IV, construction of a mini-refinery, Merowe and/or Roseires dam heightening, and development of extensive forestry plantations.

Successful and timely execution of these projects is essential to realizing the objectives of the Plan. Historically, though, such projects have encountered many problems, major and minor, which cause delays or poor performance. Consequently, the goals of the project as originelly conceived are not properly achieved. The case of Power III serves as an example.

A major objective of the Plan, therefore, is to determine ways to reduce the time between conceiving and sucessfully completing a project. A common sequence of events associated with projects has been identified:

* Projects are poorly conceived and difficult to finance.
* Once financed, they are delayed due to many obstacles and lengthy procedures both anticipated and unanticipated.
* These delays increase project costs.
* Projects then run out of money and are further delayed.
* Once completed, projects operate below capacity and are poorly maintained.

The issue of acquiring finance is addressed in Section B above. The other key problems and recommended solutions are presented in Table 5-1 below.

TABLE 5-1
KEY PROBLEMS AND SOLUTIONS

PROBLEM	RECOMMENDED SOLUITON
Planning	
Projects are improperly planned.	Achieve better planning through developing a strategic National Energy Plan and by a more rigorous identification, analysis, and review of each project by the parent organization. . Involve financiers and an independent outside consultant to review the project at the prefeasibility and feasibility levels.
Coordination	
There is a lack of coordination and clearance at the highest levels.	. Form a Ministerial Steering Committee to coordinate and oversee key projects once planned. The committee is to consist of the Minister or State Minister from agencies directly related to gaining project approval and to execution.
Organization	
Responsibility and accountability for the project are not centered in one individual or organization.	. Create an autonomous organization with independent financial and budgetery authority and an independent Director to execute the project. This entity, formed upon completion of the feasibility study, is to have sole responsibility for the project, be accountable directly to the Board Chairman, and have a staff relationship with the parent organization (e.g., GPC, NEC).

<u>Terms of Service</u>	
Incentives and terms of service are poor and so fail to attract and retain quality people.	. Provide adequate incentives to attract and retain quality personnel and ensure quality, timely work. Reward high performance and discourage poor performance.
<u>Manpower Skills</u>	
There is a lack of knowledge of the technology employed. The training provided is inadequate to gain this knowledge.	. Include overseas on-the-job operations training in the implementation phase so that operators are already experienced when the project begins full operation. . Provide training (local or overseas) to managers who will be responsible for performance of the unit once completed.

The responsibility to pursue implementation of these changes rests with each corporation as coordinated by the Higher Energy Council and reviewed by the the Office of the Minister.

D. IMPLEMENTING PROGRAMS AND POLICIES

While sucessfully completing projects will improve the energy situation over the long term, in the short run the focus must be on implementing policies and programs to more effectively use existing supplies. Such programs as demand management, tariff reform, conservation, and public awareness will improve conditions immediately as more energy will be available from the existing system. These policies and activities are fundamental to the strategies as defined in Chapter III. They are further detailed in Chapter IV.

These programs and policies require little if any finance but face their own obstacles to implementation. They must be properly designed by the responsible unit and then approved by senior managers and policymakers within the organization. In addition, a broed group of institutions and policymakers within the Energy Sector and across the Government are involved in setting and implementing any new programs. These groups must, therefore, accept and understand the changes and support their implementation.

This process is time consuming, requiring considerable human resources. Yet it is imperative it be implemented quickly or the supply/demand situation will further deteriorate. The appropriate operating units and agencies responsible for specific programs are identified in Chapter IV. The following schedule is provided to guide the activities of these units:

* Within three months draft programs and an implementation schedule are to be developed and presented within the corporation or agency.
* Within six months a formal program is to be submitted to the Higher Energy Council for review and approval.
* Within one year initial implementation is to begin.
* Within two years programs and policy changes are to be substantially implemented.

E. RESEARCH AND DEVELOPMENT

Over the long term overcoming Sudan's energy problems requires applying new technologies to the exploitation and consumption of new and indigenous resources. The first step towards realizing this future is strengthening research and development efforts. This involves developing the necessary scientific and technological infrastructure, institutions, and manpower.

The goal of the National Energy Plan is, therefore, to establish the basis for a national research and development program for energy resources and technologies. Given the high cost of R&D, limited funds and a scarcity of technical expertise, this program should focus on applied rather than theoretical research. Specifically, the effort is to be directed towards:

* Adapting proven technologies to local manufacture.
* Adapting appropriate simple technologies suitable for rural applications.
* Developing and adapting new technologies, especially those applied to new and renewable sources of energy.
* Developing the capability to solve technical problems encountered in all energy-related development projects.

Implementing this program requires coordination between the various institutions involved. For Renewables this coordination is to be provided by the Energy Research Council and the Renewables Implementation Task Force. These units are to provide overall direction for research activities. Further, they are to assist other institutions (e.g., universities and operating units) in developing active research and development programs.

Second, additional resources must be brought to bear on research. This can best be achieved by cooperation with ongoing research programs in donor as well as other developing countries. Pooling of technological capabilities and sharing information will be the best way to maximize the benefits from related efforts.

Finally, training programs must be expanded, especially at local institutions. This will ensure the development of the manpower necessary to sustain a vibrant research program over the long run.

F. PLANNING AND INFORMATION SYSTEMS

A fundamental objective of the Plan is to develop a system for planning and review. Planning is a process not an event and so must be responsive to future changes in conditions. The two main elements in this process are information systems and institutionalized planning.

1. Information Systems

The energy planning information system should allow high-level decisionmakers in the Energy Sector to define appropriate policies and plans. The major component of it is the supply and demand analysis. Information units in GPC, NEC, and the Forestry Department should be improved to collect reliable supply and demand data.

Another component of the system is resources data, which could be collected jointly by GMRC, NEA, Energy Research Council, Forestry and Agriculture authorities as well as the Ministry of Irrigation.

A third component of the system is technology data and local production capabilities. This information should be collected by the NEA and by research and industrial institutions.

This national information system should be complemented by collection of national economic data and trend analysis.

The National Energy Administration's role is to monitor the process of collection as well as storage, retrieval and analysis and to reproduce data according to the needs of decisionmakers periodically. The system should serve ministerial levels as well as coordinate planning of different energy institutions and researchers.

2. Institutionalizing the Planning Process

The major step forward made in the planning process by this National Energy Plan will be the basis for more improvements in the future. Planning must be continuous, adapting to changes in conditions. So within the Ministry every year the Plan will be reviewed and updated. This process consists of:

a. Updating the demand forecast.

b. Agreement between the Higher Energy Council and the Minister on the strategies to meet or modify these demands.

c. Development of specific investment programs, policies and plans to meet those strategies.

d. Review and approval by the Minister and the Higher Energy Council.

6. FOLLOW THROUGH

To successfully put the Plan into effect, the major initiatives must be understood and agreed to by all concerned parties and then acted upon on a timely basis. All obstacles encountered must be overcome.

Responsibilities for undertaking specific actions are clearly spelled out in the Executive Summary, this Main Report and the Committee Reports. The NEA is responsible for leading an effort to explain and promote the Plan. This includes development of presentations and materials for a wide audience.

Overall responsibility for follow up and monitoring of implementation is vested in the Higher Energy Council. The role of the Council's Secretariat is to monitor progress, identifying problems and potential difficulties. The role of the Council is to work out these problems as they arise (as identified by the Secretariat), and coordinate activities of the appropriate bodies. In addition, all units will report every six months to the Higher Energy Council on progress towards implementing the Plan.

* * * * *

With a vigorous, well-directed effort at change Sudan can improve the energy future by providing enough supply at an affordable cost to meet the demands of the economy. Let this National Energy Plan serve as the commitment of the Nation and its Government to turn that idea into action.

APPENDIX 1

ABBREVIATIONS

BOS = Bank of Sudan

ERC = Energy Research Council

GMRD= Geological and Mineral Resources Department

GPC = General Petroleum Corporation

MEM = Ministry of Energy and Mining

MFP = Ministry of Finance and Economic Planning

MOA = Ministry of Agriculture

NCR = National Council for Research

NEA = National Energy Administration

NEC = National Electricity Corporation

PSR = Port Sudan Refinery

TABLE NEP-1

NATIONAL ENERGY PLAN

PROPOSED INVESTMENT PROGRAM

SUMMARY

	1985-1990 (MM $)	1991-2000 (MM $)	TOTAL (MM $)
Petroleum			
Refining	96	678	744
Other	41	-	41
Subtotal	137	678	815
Electricity			
Grids	1,125	1,484	2,609
Regions	423	800	1,223
Subtotal	1,548	2,284	3,832
Wood Fuels			
Plantations	188	377	565
Other	93	186	279
Subtotal	281	563	844
Renewables			
Studies	3	4	7
Dissemination	7	9	16
Subtotal	10	13	23
Hydrocarbons			
Promotion	12	5	17
Subtotal	12	5	17
TOTAL	1,988	3,543	5,531
PER YEAR	331	354	

PETROLEUM PROJECTS AND PROGRAMS

PROJECT/PROGRAM	OBJECTIVE	RESPONSIBILITY	COST (MM$)	TIMING/IMPLEMENTATION
* Petroleum Import Facility.	Increase imports by dedicating adequate foreign exchange and purchasing at least cost.	GPC BOS	None	Immediate action required.
* Demand Management Program.	Reduce nonessential or low priority consumption.	GPC NEA	Small	Design program immediately; implement within one year
* Economic Cost Based Pricing.	Increase Energy Sector revenues; reduce nonessential consumption.	GPC MFP NEA	None	Develop pricing objectives and program within six months; implement changes progressively over two years.
* Port Suden Refinery Rehabilitation.	Improve efficiency of refinery.	GPC PSR	281	Secure initial finance; complete rehabilitation over three years.
* Minirefinery (15,000 bpd).	Provide secure and economical fuel oil for essential needs (power generation, strategic industries).	GPC	83	Secure finance immediately. Begin construction within one year. Complete by 1988.
* Upgrade of Rail, Storage, Transport and Blending Facilities	Improve efficiency of delivery system.	GPC	41	Secure initial finance; implementation over five years.
* Inland Refinery	Provide refinery capacity for the 1990s.	GPC	650	Study feasibility over next three years.

Table NEP-2
PETROLEUM INVESTMENT PROGRAM
Near Term (1985-1990)

	Foreign Component (MM$)	Local Component (MM LS)	Total (MM$)
Refining			
Port Sudan Refinery Rehabilitation	-	15.0	11.5
New Inland Refinery	69.0	19.5	84.0
Subtotal	69.0	34.5	95.5
Transportation			
Port Sudan-Marsa Nimeiri Pipeline	5.4	0.8	6.0
Shendi Booster Station	9.5	1.5	11.0
Subtotal	14.9	2.3	17.0
Storage			
Fao/Rabak	2.8	0.4	3.1
Shagare	8.5	1.6	9.7
Atbara	1.2	0.2	1.3
Kordofan	0.8	0.1	0.8
Darfur	0.5	0.1	0.5
Southern Sudan	0.3	0.1	0.3
Subtotal	14.1	2.5	15.7
Blending			
Sudan Oil Blending Plant	8.4	0.3	8.7
TOTAL	106.4	39.6	136.9
	Long Term (1991-2000)		
Refining			
Port Sudan Rehabilitation	-	36.0	28.0
New Inland Refinery	650.0	-	650.0
TOTAL	650.0	36.0	678.0
Near Term + Long Term	756.4	75.6	814.9

ELECTRICITY PROJECTS AND PROGRAMS

PROJECT/PROGRAM	OBJECTIVE	RESPONSIBILITY	COST (MM$)	TIMING/IMPLEMENTATION
* Debottlenecking: Technical System Efficiency Improvement and Loss Reduction.	Gain supply through improved efficiency; increase reliability.	NEC	20-40	Begin immediately
* Conservation & Load Management Program.	Reduce nonessential electricity usage.	NEC NEA	Small	Design immediately, Implement within one year.
* Tariff & Collection Reform.	Improve financial performance; encourage efficient consumption.	NEC	Small	Design immediately; implement within one year.
* Commercialize Electricity operations.	Operate NEC on an efficient self-sustaining basis, eliminating subsidies.	NEC MFP MEM	None	Design program within one year; implement in second year.
* Power IV (170 MW thermal) (70 MW hydro)	Provide power facilities for late 1980s.	NEC MFP	300	Secure finance immediately, begin construction within one year.
* Regional Electrification.	Upgrade existing system. Provide power to 55 new urban centres.	Regions NEC NEA	422	Assist regions with existing system immediately. Prepare for expansion after three years.
* Expansion of Hydro Power Facilities: Merowe & Roseires Heightening	Provide Indigenous, inexpensive power for the 1990s.	NEC MFP	700	Conduct feasibility study; secure finance within one year: begin construction after two years.

Table NEP-3
ELECTRICITY SECTOR INVESTMENT PROGRAMS
NO FINANCIAL CONSTRAINTS
Near Term (1985-1990)

	Foreign Component (MM$)	Local Component (MM LS)	Total (MM $)
Blue Nile and Eastern Grids			
Debottlenecking*	30.0	5.0	33.8
Rehabilitation	42.2	5.0	48.0
Generation			
Thermal	181.5	50.0	220.0
Hydro	405.8	99.0	482.0
Transmission + Distribution	198.0	130.0	296.0
Fuel Transport	38.0	-	38.0
Studies	8.2	1.0	9.0
Total Grids	901.7	290.0	1,124.8
Isolated Systems			
Debottlenecking*	20.0	5.0	23.8
Generation	154.4	45.0	180.0
Transmission + Distribution	52.8	25.0	72.0
New Urban centres	94.7	55.0	137.0
Total Isolated Systems	321.9	130.0	422.8
Total Near Term	1,223.6	420.0	1,547.6
Long Term (1991-2000)			
Blue Nile and Eastern Grids			
Generation			
Hydro	870.5	180.0	1,009.0
Thermal	148.1	35.0	175.0
Transmission + Distribution	261.5	50.0	300.0
Total Grids	1280.1	265.0	1,484.0
Isolated Systems			
Generation	364.5	30.0	385.0
Transmission + Distribution	203.1	35.0	230.0
New Urban Centres	127.3	75.0	185.0
Total Isolated Systems	694.8	160.0	800.0
Total Long Term	1,957.0	425.0	2,284.0
TOTAL LONG + NEAR TERM	3,190.6	845.0	3,831.0

* Partial estimate, excludes certain items not quantified in Subcommittee Report.

INDIGENOUS RESOURCES PROJECTS AND PROGRAMS

PROJECT/PROGRAM	OBJECTIVE	RESPONSIBILITY	COST (MM$)	TIMING/IMPLEMENTATION
WOOD FUELS				
* Creation of High Level Task Force.	Define strategies, program and organization to tackle forestry/land use management problem.	MOA MEM	Small	Task Force formed within six months. Makes final recommendations within one year.
* Reinfed Plantation Development	Increase supply of of wood fuels.	High Level Task Force	461	Design program; secure initial finance within one year (157 MM$)
* Irrigated Plantation Development.	Secure ecological balance.	MOA (Forestry) NEM	7	Design program; arrange finance; implement over five years.
* Resource Managment & Conservation Program.	Efficient use of existing resource; raduce nonessential demand.	MOA (Forestry) NEA ERC	252	Design program; implement over 15 years.
HYDROCARBONS				
* Resource Assessment.	Maximize Energy supply from indigenous resources for late 80s and 90s.	GMRD, GPC, NEA		Begin immediately.
* Development Promotion, Exploration.		NEA, GMRD, GPC	12	Financed by World Bank.
* Development and Commercialization.		Private Sector	-	Financed by Private Sector.
RENEWABLES				
* Create Renewables Task Force.	Define program and coordinate activities of institutions.	MEM NCR	Small	Form Task Force immediately. Task Force conclude work within one year; continued if justified
* Renewables Development program	Establish economic + technical feasibility of new technologies.	Renewables Task Force		
1. Studies, development and tests		ERC NEA	3	Design program & finance; implement over 2-3 years; Phase 1 complete after 5 years
2. Create Commercial Promotion Center.	Promote dissemination and manufacturing to commercialize new technologies.	ERC NEA Private Sector	8	Phase 2 begins after completion of Phase 1.

Table NEP-4

WOOD FUELS INVESTMENT PROGRAM

Project	(1985-1990) (MM$)	(1991-2000) (MM$)
1. Development of Forest Resource		
Reforestation		
Rainfed	179.2	359.0
Irrigated	8.9	17.3
Resource Management	76.9	153.9
2. Conservation, Institution, Training and Research	16.2	32.5
TOTAL	281.2	562.9

Total Investment (1985-2000) = $844.1 MM

Table NEP-5

RENEWABLES (EXCLUDING WOOD FUELS) INVESTMENT PROGRAM
(1985-2000)

Activities	Short Term (1985-1990)		
Resources & Technology	Solar, Wind, Mini-Hydro	Biogas, Gasification, Briquetting	Subtotal
	(MM LS)	(MM LS)	(MM LS)
Studies Research and Field Test	2.76	.90	3.66
Dissemination and Manufacturing	5.52(1)	3.66(1)	9.18
Total	8.28	4.56	12.84

Activities	Long Term (1990-2000)(2)		
Resource & Technology	Solar, Wind, Mini-Hydro	Biogas, Gasification, Briquetting	Subtotal
Studies, Research and field Test	4.56	1.20	5.70
Dissemination and Manufacturing	6.00	6.00	12.00
Total	10.56	7.20	17.76

Total investments, short term 1985-1990 13.4(3)
Total investments, long term 1991-2000 17.8
Total investments, 1985-2000 31.2
The percentage of the foreign component in this investments is 50%.

(1) 3 MM LS are added for the Renewables Promotion Center.
(2) Estimates for follow-up program of Phase II (1990-2000) have been based on figures of Phase I (1985-1990).
(3) 30% of the manpower budget is added as wages for the unskilled labor.

APPENDIX 2

PARTICIPANTS IN THE PREPARATION OF THE NATIONAL ENERGY PLAN

INSTITUTIONS

The Ministry of Energy & Mining (MEM)

(A) National Energy Administration (NEA)

(B) General Petroleum Corporation (GPC)

(C) National Electricity Corporation (NEC)

(D) Power III Project

(E) Geology and Mineral Resources Dept. (GMRD)

Ministry of Irrigation

Energy Research Council (ERC)

Renewable Energy Research Institute (RERI)

Sudan Renewable Energy Project (SREP)

Forestry Dept., Ministry of Agriculture and Natural Resources

Forestry Research Institute

Dasert Combating and Rehabilitation Program

Ministry of Finance and Economic Planning

Ministry of Transport and Communication

National Council for Research (NCR)

COMPANIES

E/DI

Chevron

Alexander Gibb

Merz and McLellan

SWECO

Motor Colombus

TOTAL Marketing Company

Shell Marketing Company

AGIP Marketing Company

Mobil Marketing Company

American Agency for International Development (USAID)

INDIVIDUAL PARTICIPANTS IN THE PREPARATION OF THE NATIONAL ENERGY PLAN

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Dr. Hummida Al Hussein	NEC
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Dr. A/Rahiem Ahmed Belal	NEA/E/DI
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Syd A/Fattah A/Kariem	Power III Project

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Syd Gabra Stawro	NEC
Syd Tag Elsir Ahmed	Ministry of Irrigation
Syd Farouk Shaalan	MEM
Syd Mubarak Omer Adam	GPC
Syd Mohd. Galal Eldin	Ministry of Finance and Economic Planning
Syd A/Bagi A/Alla	GPC
Syd Hassan Elzubeir	GPC
Syd Abubaker A/Rahman	Forestry Dept.
Syd Hassan Zaki	Forestry Dept.
Syd Mohd. Hanafi Obied	Forestry Dept.
Syd Ahmed Hassan Ali	GPC
Syd Mohd. El Hassan Aloob	NEC
Syd Mohd. El Amin Ahmed	Forestry Dept.
Syd Gaafer El Faki Ali	NCR
Syd Victor Saba Wahba	Ministry of Finance and Economic Planning
Syd Mohd. Mohd. El Hassan	Geology Dept.
Syd A/Rahiem Ahmed	GPC
Syd Ibrahiem Ali	Merz and McLellan
Syd Salah Awadall Salih	Energy Consultation

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Syd Mohd. Osman Nugud	GPC
Syd Mohd. Elfadly Mahmoud	NEC
Syd Abayo Wat	GPC
Syd Hisham Elsayed Elfile	GPC
Syd Allam Elhudde Mohd. Elhassan	GPC
Syd A/Rahman El Tilib	GPC
Syd A/Azziz Gassim Marhoum	GPC
Syd A/alla Ahmed Elkhalifa	GPC
Syd Ahmed Mohd. Ibrahiem	GPC
Syd Ahmed Khalil	GPC
Syd Salih Gaafer Mohd.	GPC
Syd Mahmoud Sharief	NEC
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Syd Mohd. El Amin Suliman	Power III Project
Syd Osman Eltoom	Ministry of of Irrigation
Syd Gaafer El Tenyi	NEC
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Syd Hamid El Mamoon Elrieh	NEC
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Syd Ali Mukhtar Nourien	GPC
Syd Kamal A/Rahiem	GPC
Syd Mohd. A/Rahiem	GPC
Syd Awad Ali Belal	GPC
Syd Fisal Yahia Abu Elgassim	GPC
Syd Issam El Amir	GPC
Syd Taha El Sukky	GPC
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Syd Hamza Humoudi	RERI
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Syd Eltag A/Muntalab	Ministry of Finance and Economic Planning
Miss Amna Mohd. Saeed	Ministry of Finance and Economic Planning
Miss Samia El Riah	Ministry of Finance and Economic Planning
Syd Ismail El Gizouli	NEA
Syd Ahmed Elzein Elhassan	NEA
Syd Ishag Adam Bashir	NEA

NAME	ENTITY
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Syd A/Halim Ahmed Elshiekh	NEA
Syd A/Salam Ahmed	NEA
Syd Farah A/Mageed	NEA
Syd Hassan Bashir	NEA
Syd Abubaker Mahgoub	NEA
Syd Ali A/Kariem	NEA
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Syd Mohd. Salih Farah	NEA
Syd Mussad A/Alla	NEA
Syd Rashid Makky	NEA
Mrs. Fatima Ibrahiem Anis	NEA
Miss Maha Mohd. Ahmed	NEA
Miss Igbal El Saddig	NEA
Syd A/Alla A/Mutaal	NEA
Syd Mohd. Mohmdian El Tigani	NEA
Syd Salah Ali Mohd. Nour	NEA
Miss Kawther Abd Elsaddig	NEA
Miss Mariam Ahmed Musa	NEA
Miss Soad Siddig	NEA
Miss Iklass Gassim	NEA
Syd Ahmed A/Gader Abu Sam	NEA

NAME	ENTITY
Syd Ahmed Osman	NEA
Syd Hisham Bakry	GPC
Syd Mohd. Nabil Fahmy	AGIP Company
Syd Taha Al Balla	AGIP Company
Syd El Fadil Khalaf Alla	GPC
Dr. Amal El Tigani	Kuwait University
Syd Ismail Shams Eldin	NEA
Syd Mohd. Fouz Mohd. Ali	NEA
Prof. Ronald Larson	SREP
Dr. Heinz Rade	RERI
Mr. Paul Cough	E/DI
Mr. Edward Hepper	Alexander Gibb
Mr. Gene R. Harris	E/DI
Mr. G. H. Connell	Chevron
Mr. Eric Small	Alexander Gibb
Mr. Dennis Monaghan	E/DI
Mr. Merc Daudon	E/DI
Mr. Terence Dulley	Merz and McLellan
Mr. Nigel Widgery	Alexander Gibb
Mr. Gunner Sparrman	SWECO
Mr. Dan Ladd	Chevron
Mr. Mathew Gamser	RERI
Mr. Quiririo Farrario	Motor Colombus

NAME	ENTITY
Mr. Roland Moegerle	Motor Colombus
Mr. Seyoum Solomon	E/DI
Mr. Frank Laukakan	E/DI
Mr. James Westfield	E/DI
Mr. Scott Rogers	E/DI

THE COMMITTEES OF THE NATIONAL ENERGY PLAN

Phase I:

The National Energy Plan Committee was established in April 1983 based upon a ministrial decree issued by the Minister of Energy and Mining and from this committee seven technical committees were formed as follows:

1. The Energy Demand Forecast Technical Committee.
2. Energy Supply and Resources Technical Committee.
3. Dobottlenecking Technical Committee.
4. Renewable Energy Technical Committee.
5. Energy Conservation and Demand Management Technical Committee.
6. Technoeconomic Options Technical Committee.
7. Plan Implementation Technical Committee.

Phase II:

Consisted of eight committees including one main committee called the Chairman's Committee beside seven other subcommittees as follows:

1. Technoeconomic Options Technical Committee consisting of:
   a. Renewable Energy Subcommittee.
   b. Electricity Subcommittee.
   c. Petroleum Subcommittee

2. Debottlenecking Committee consisting of:
   a. Electricity Subcommittee
   b. Petroleum Subcommittee
   c. Dams Subcommittee
3. Organization and Management Committee for the Energy Sector
4. Research and Studies Committee
5. Plan Implementation Committee
6. Strategies and Objectives Committee
7. Chairman's Committee
8. Steering and Editing Committee

Total Number of Meetings

During Phase I about 53 meetings were held and during Phase II about 137 meetings were held.

NAMES OF COMMITTEES MEMBERS

PHASE I

NATIONAL ENERGY PLAN MAIN COMMITTEE

NAME	ENTITY
Syd Mohd. El Amin Mukhtar	MEM
Dr. A/Rahman Ali Shulli	NEA
Dr. John Gindi	NEC
Syd A/Alla Hassan Ishag	Geology Dept.
Syd Abbas Hidayatalla	Ministry of Irrigation
Syd Mohd. Galal Eldin	Ministry of Finance and Economic Planning
Syd A/Bagi A/Alla	GPC
Syd Hassan Zaki	Forestry Dept.
Syd Abu Baker A/Rahman	Forestry Dept.
Syd Ismail El Gizouli	NEA
Dr. Musa Babiker	NCR
Dr. A/Rahiem Belal	NEA
Syd Ahmad Hassan Ali	GPC
Syd Gabra Stawro	NEC
Dr. Hassan Wardi	ERC
Syd Ismail Shams Eldin	NEA
Syd Mohd. Fawz Mohd. Ali	NEA
Miss Kawther A/Saddig	NEA
Miss Marim Ahmad Musa	NEA
Miss Soad Siddig	NEA

FORECAST TECHNICAL DEMAND COMMITTEE

NAME	ENTITY
Dr. A/Rahman Ali Shulli	NEA
Syd Ismail El Gizouli	NEA
Syd Farah A/Mageed	NEA
Syd Mahmoud A/Rahiem	GPC
Syd Hassan Zaki	Forestry Dept.
Syd Gabra Stawro	NEC
Mr. Paul Cough	E/DI
Syd Dawood Gabr	Alexander Gibb
Syd Mohamedain Eltigani	NEA
Miss Samia El Riyah	Ministry of Finance and Economic Planning
Mr. Scott Rogers	E/DI
Syd El Tag A/Mutalib	Ministry of Finance and Economic Planning
Mrs. Nour A/Mageed	NEA

ENERGY SUPPLY AND RESOURCES COMMITTEE

NAME	ENTITY
Syd A/Alla Hassan Ishag	Geology Dept.
Syd Mohd. Hanafi Obied	Forestry Dept.
Syd Ibrahiem Ali	Merz and McLellan
Syd Gabre Stawro	NEC
Dr. Mohd. Osman Nugud	GPC
Miss Amna Mohd. Saad	Ministry of Finance and Economic Planning
Syd Abu Bakir Mahgoub	NEA
Miss Mariam Ahmed Musa	NEA
Syd Ali A/Kariem	NEA

ADMINISTRATION COMMITTEE

CONSERVATION OF ENERGY AND DEMAND

NAME	ENTITY
Syd Mohd. El Amin Mukhtar	MEM
Dr. A/Rahman Ali Shulli	NEA
Dr. John Gindi	NEC
Syd Mohd. Elhassan Aloob	NEC
Syd Mohd. El Amin Ahmed	Forestry Dept.
Syd A/Haliem Ahmed Elshiekh	NEA
Syd A/Salam Ahmed	NEA
Mrs. Fatima Ibrahiem Anis	NEA
Syd Ali Noureen	GPC
Mr. Paul Cough	E/DI
Miss Soad Siddig	NEA

DEBOTTLENECKING TECHNICAL COMMITTEE

NAME	ENTITY
Syd Farouk Shaalan	MEM
Syd A/Rahiem Ahmed	GPC
Syd Ibrahiem Ali	Merz and McLellan
Syd Abbas Hidatalla	Ministry of Irrigation
Mr. Paul Cough	E/DI
Mr. Dan Ladd	Chevron
Syd Amin Sabry	NEC
Syd Hussan Bashir	NEA

PLAN IMPLEMENTATION TECHNICAL COMMITTEE

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Syd Ismail El Gizouli	NEA
Dr. Humeeda El Hasseen	NEA
Syd Victor Saba	Ministry of Finance and Economic Planning
Syd Ahmed Hassan Ali	GPC
Syd Mohd. Salih Farah	NEA
Syd A/Alla Elazzrag	NEA
Syd Edward Happer	Alexander Gibb
Mr. Paul Cough	E/DI

TECHNOECONOMIC OPTION COMMITTEE

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Syd Abyo Watt	GPC
Syd Ibrahiem Ali	Merz and McLellan
Syd Ismail Shams Eldin	NEA
Syd Edward Hepper	Alexander Gibb
Mr. Marc Daudon	E/DI

RENEWABLE ENERGY TECHNICAL COMMITTEE

NAME	ENTITY
Dr. A/Rahiem Ahmed Belal	NEA
Dr. Shoomo Shaa Eldin	ERC
Dr. Hassan Wardi	ERC
Syd Gaafer El Faki Ali	NCR
Syd A/Haliem Ahmed Elshiek	NEA
Syd Masaad A/Alla	NEA
Syd A/Alla A/Mutaal	NEA
Dr. Heinz Rade	RERI
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NAMES OF COMMITTEE MEMBERS

PHASE II

PETROLEUM SUBCOMMITTEE

NAME	ENTITY
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Syd Hassan El Zubier Eltahir	GPC
Syd Ahmed Hassan Ali	GPC
Syd A/Bagi A/Alla	GPC
Syd Hisham Elsayd Alfile	GPC
Dr. Allam El Huda M. Elhassan	GPC
Syd Ahmed Khalil	GPC
Syd A/Azziz Gasim Marhoom	GPC
Dr. Ahmed Mohd. Ibrahiem	GPC
Syd Salih Gaafer Mohd.	GPC
Syd Mubarak Omer Adam	GPC
Syd Ishag Adam Bashir	NEA
Syd Ismail Shams Eldin	NEA
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ELECTRICITY SUBCOMMITTEE

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Dr. John Gindi	NEC
Syd Amin Sabry	NEC
Syd Ahmed Elzien	NEA
Syd Ishag Adam Bashir	NEA
Syd Mubarak Omer Adam	GPC
Syd A/Rahiem Eltilib	GPC
Syd A/Bagi A/Alla	GPC
Syd Hassan Elzubier Eltahir	GPC
Syd Gebra Stawro	NEC
Syd Ismail Shams Eldin	NEA
Syd Salah Ali Mohd. Nour	NEA
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RENEWABLE ENERGY COMMITTEE

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Prof Ahmed Alhury	Forestry Research Centre
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Syd Gaafer El Faki	NCR
Syd A/Alla A/Mutaal	NEA
Miss Igbal El Saddig	NEA
Syd Selah Awadalla	Motor Colombus
Dr. Heinz Rade	RERI
Syd Gabra Stawro	NEC
Mr. Eric Small	Alexander Gibb
Mr. Gunner Sparrmen	SWECO
Mr. Dennis Moneghan	E/DI
Miss Soad Siddig	NEA
Syd Ibrahiem Ali	Merz and McLellan

PETROLEUM DEBOTTELENCKING SUBCOMMITTEE

NAME	ENTITY
Syd Ahmed Elzein	NEA
Syd Mohd. Ahmed Talat	MEM
Syd Farouk Shalaan	MEM
Syd Mawia Habib Alla	Port Sudan Refinery
Syd Omer Mahmoud	Ministry of Transportation and Communication
Syd Ali Muktar Noureen	GPC
Syd Hassan Bashir Nimir	NEA
Miss Mariam Ahmed Musa	NEA
Syd Hassan El Zubier	GPC
Syd A/Alla A/Mutaal	NEA

DAMS DEBOTTLENECKING SUBCOMMITTEE

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Syd Tag Elsir Ahmed	Ministry of Irrigation
Syd Mohd. Ahmed Telaat	MEM
Syd Osman El Toum	Dams & Irrigation Dept.

ENERGY ORGANIZATION & MANAGEMENT SUBCOMMITTEE

NAME	ENTITY
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Syd Hassan El Zubier	GPC
Syd El Fadil Khalfalla	GPC
Syd Hamed El Niel A/Gader	GPC
Syd Ishag Adam Bashir	NEA
Mrs. Fatima Ibrahiem Anis	NEA

RESEARCH & DEVELOPMENT COMMITTEE

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Syd Ishag Adam Bashir	NEA
Miss Maha Mohd. Ahmed	NEA

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Syd A/Moeen Satti	NEA
Syd Mohd. Amin Suliman	Power III Project
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CHAIRMAN'S COMMITTEE

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Syd A/Fattah A/Kariem	NEC
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Syd Abbas Hidyatalla	Ministry of Irrigation
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Syd Mohamadain Eltigani	NEA
Mr. Marc Daudon	E/DI

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Syd Ishag Adam Bashir	NEA
Syd Salah Awadalla	Motor Colombus
Syd Amin Sabry	NEC
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