ESMAP

Energy Sector Management Assistance Programme

ESM193

Uganda

Energy Assessment

Report No. 193/96

JOINT UNDP / WORLD BANK
ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

PURPOSE

The Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) is a special global technical assistance program run by the World Bank's Industry and Energy Department. ESMAP provides advice to governments on sustainable energy development. Established with the support of UNDP and 15 bilateral official donors in 1983, it focuses on policy and institutional reforms designed to promote increased private investment in energy and supply and end-use energy efficiency; natural gas development; and renewable, rural, and household energy.

GOVERNANCE AND OPERATIONS

ESMAP is governed by a Consultative Group (ESMAP CG), composed of representatives of the UNDP and World Bank, the governments and other institutions providing financial support, and the recipients of ESMAP's assistance. The ESMAP CG is chaired by the World Bank's Vice President, Finance and Private Sector Development, and advised by a Technical Advisory Group (TAG) of independent energy experts that reviews the Programme's strategic agenda, its work program, and other issues. ESMAP is staffed by a cadre of engineers, energy planners, and economists from the Industry and Energy Department of the World Bank. The Director of this Department is also the Manager of ESMAP, responsible for administering the Programme.

FUNDING

ESMAP is a cooperative effort supported by the World Bank, UNDP and other United Nations agencies, the European Community, Organization of American States (OAS), Latin American Energy Organization (OLADE), and public and private donors from countries including Australia, Belgium, Canada, Denmark, Germany, Finland, France, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, the United Kingdom, and the United States.

FURTHER INFORMATION

An up-to-date listing of completed ESMAP projects is appended to this report. For further information or copies of completed ESMAP reports, contact:

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UGANDA

ENERGY ASSESSMENT

DECEMBER 1996

Power Development, Efficiency &
Household Fuels Division
Industry and Energy Department
The World Bank
1818 H Street, N.W.
Washington, D. C. 20433

CURRENCY EQUIVALENTS

Currency Unit = Uganda Shilling (USh)
1 US$ = 900 USh (February 1994)
1 US$ = 1,000 USh (March 1996)

ABBREVIATIONS AND ACRONYMS

ESMAP	Energy Sector Management Assistance Programme (UNDP/World Bank)
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GMU	Grant Management Unit (APE Project)
GNP	Gross National Product
GOU	Government of Uganda
GTZ	Gesellschaft für Zusammenarbeit (German Cooperative Development Agency)
HEPP	Household Energy Planning Programme
IBRD	International Bank for Reconstruction and Development (World Bank)
ICB	International Competitive Bidding
IDA	International Development Agency (World Bank Group)
IFC	International Finance Corporation (World Bank Group)
IPP	Independent Power Producer
JEEP	Joint Energy and Environment Programme (Uganda)
JICA	Japanese International Cooperation Agency
KCJ	Kenya Ceramic Jiko
LPG	Liquefied petroleum gas
LRMC	Long-Run Marginal Cost
MAAIFP	Ministry of Agriculture, Animal Industry and Fish Production
MCIC	Ministry of Commerce, Industry and Cooperatives
MFEP	Ministry of Finance and Economic Planning
MIGA	Multilateral Investment Guarantee Agency (World Bank Group)
MOH	Ministry of Health
MNR	Ministry of Natural Resources
MTWA	Ministry of Tourism, Wildlife and Antiquities
NEAP	National Environmental Action Plan
NFS	Norwegian Forestry Society
NGO	Non-Governmental Organization
NORAD	Norwegian Agency for International Development
NRC	National Resistance Council (Parliament)
NRSE	New and Renewable Sources of Energy
ODA	Overseas Development Administration (UK)
RC	Resistance Council (national administration system at village, parish, district and regional level)

SIDA	Swedish International Development Agency
UEB	Uganda Electricity Board
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
USIKA	Improved stove organization

WEIGHTS AND MEASUREMENTS

GJ	Giga Joule (1,000 million joules = 10^9 joules)
GW	Gigawatt (1,000 million watts = 10^9 watts)
GWh	Gigawatt hour (= 10^9 watt hours)
Joule	Amount of energy to move 9.81 kg one metre
kcal	kilocalorie (4.19×10^{-3} MJ)
kg	kilogram (1,000 grams; 2,205 pounds)
kW	kilowatt (1,000 watts)
kWh	kilowatt hour (1,000 watt hours)
MJ	Mega Joule (1 million joules = 10^6 joules)
MT	Metric tonne (1,000 kg)
MW	Megawatt (1 million watts = 10^6 watts)
MWh	Megawatt hour (= 10^6 watt hours)
TJ	tera-Joule (one million mega joule)
tons	metric tons (1,000 kg)
TOE	tons of oil equivalent (10.2 million kcal = 42.5G GJ)

$1m^3$ stacked wood	=	stere
	=	0.7 m^3 solid wood
$1m^3$ solid	=	600 kg (0.6 metric tonnes)
$1m^3$ stacked	=	420 kg (0.42 metric tonnes)
1 kg wood	=	15 MJ (air-dried)
1 kg charcoal	=	30 MJ
1 kg coal	=	30 MJ
1 kg fuel oil	=	42 MJ

Moisture content of freshly cut wood = > 60% on air dry basis
Moisture content of air dried wood = 15% on air dry basis

FISCAL YEAR

January 1 -December 31

PREFACE

The Government of Uganda has requested ESMAP's assistance to undertake an assessment of the energy sector and recommend a development strategy for the sector. Despite the rehabilitation effort undertaken by the present Government in recent years, the Uganda energy sector is still a constraint to the country's economic development. Meeting the energy demand of rapidly growing urban and rural sectors will require substantial private and public investments; the challenge is for this to be done efficiently, to maximize economic growth and development.

This report identifies major issues and outlines options for increasing efficiency in the petroleum, power, renewable and traditional energy sub-sectors. Chapter I discusses the role of the energy sector in the Uganda economy; Chapter II focuses on the best alternatives to ensure cost effective supply and maximum competition in the petroleum sub-sector; Chapter III looks at the reforms needed in the power sub-sector to improve the performance of the public power utility, promote the participation of the private sector and expand electrification; and Chapter IV concentrates on options for improving production and utilization of renewable and traditional energy to raise the welfare of the population and reduce pressure of biomass consumption on the environment. The report was discussed at a Workshop on Energy Sector Assessment and Power Sector Reform Options for Uganda held in Kampala on August 19-20, 1996. The Report of the Rapporteur General of the Workshop is attached as Annex 4.5.

This report is based on the findings and recommendations of an energy assessment mission that visited Uganda in February 1994 and a follow-up mission to review the renewable energy sector which took place in May 1995. The team consisted of Peter Eglington (Mission Leader), Emilia Battaglini (Economist), Luis Cosenza (Power Utility Specialist), Kevin Fitzgerald (Household Energy Specialist) Ken Hornby (Petroleum Downstream Specialist), Keith Openshaw (Woodfuels Specialist), René Ribi (Power Generation Specialist), Jack Ruitenbeek (Environment Specialist). Mike Bess carried out the renewable energy review. The mission worked closely with the Energy Task Force established by the Ministry of Natural Resources and was joined by local consultants during the field work. Valuable input during the preparation of the report was received from John Besant-Jones, Michel Del Buono, Peter Dewees, Richard Dosik, Gregory Fazzari, Willem Floor, Winston Hay, Mangesh Hoskote, Paivi Koljonen, Eleodoro Mayorga-Alba, Robert van der Plas, Karen Rasmussen, Bocar M. Thiam, and Godfrey Turyahikayo. The draft report was prepared by Emilia Battaglini. This report was updated and completed by Paivi Koljonen. Secretarial support was provided by Janine Littleford, Nina Jones and word processing by Linda Walker-Adigwe and Vonica Burroughs.

The energy assessment team wishes to express the greatest appreciation to the Government of Uganda and to the enterprises and organizations operating in the Uganda energy sector for their participation in this study, their cooperation and assistance.

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EXECUTIVE SUMMARY

A. THE ENERGY SECTOR

1. Total energy consumption in Uganda is estimated at about 5 million tons of oil equivalent (toe). About 90 percent of this is biomass -- wood, charcoal and agricultural residues -- which provide energy to most households and many industrial and commercial establishments. With an estimated population of about 18 million, Uganda's per capita total energy consumption (0.3 toe) is comparable to that of Ethiopia but lower than Kenya's and Tanzania's. Given the low income of most of the population, it is difficult to envisage a rapid switching to modern fuels such as kerosene and LPG, a characteristic of many developing countries.

2. The modern segment of the energy sector - electricity and petroleum - is small. Few people have access to modern energy supplies and the country has one of the lowest per capita consumption levels of modern energy in sub-Saharan Africa (0.02 toe). Despite Uganda's vast hydropower resources concentrated on the White Nile River, only 5 percent of the population has access to electricity. With continued strong economic growth and concurrent high energy demand growth, projected at about 7 percent per year, Uganda needs to accelerate its efforts to utilize its domestic energy resources, mainly hydropower, and promote cost-effectiveness in the supply of petroleum products.

3. The Ministry of Natural Resources (MNR) is responsible for the management and development of the country's water, forests, energy and mineral resources. MNR has the responsibility for setting policies and strategies for commercial energy and currently supervises and regulates both the power and petroleum sub-sector operations. The state-owned Uganda Electricity Board (UEB) is responsible for power generation, transmission and distribution. Petroleum procurement and distribution are handled by five major international oil companies, of which two are part government-owned; and one local company.

4. To ensure effective policy making and oversight of the energy sector, the MNR should continue to build its capacity, in particular, with respect to monitoring the operations in the petroleum sub-sector, ensuring commercial orientation in the power sub-sector, and promoting energy conservation. In addition, the Government should increase its capacity to develop an efficient regulatory framework for the energy sector and evaluate options for private sector participation.

5. Neglect of the energy sector, like all areas of infrastructure, is a legacy of nearly 15 years of political turmoil, civil strife and economic decline. Over the past few years, the Government has worked to implement an economic recovery program which gives high priority to the rehabilitation, expansion and maintenance of infrastructure. The economy has responded favorably to the reform program. Real GDP increased by an average of 6.4 percent per year over the period 1987-1995.

6. Meeting the energy demands of a growing economy on a sustainable and efficient basis and improving the living standards of the population is a major challenge to the Government. This report seeks to identify the critical issues facing the energy sector and discuss options for increasing its contribution to Uganda's economic well being. The main findings are summarized below.

B. PETROLEUM

7. If the economy continues to grow and modernize, petroleum demand can be expected to rise rapidly from the current low level of some 400 million liters per year. Since Uganda does not have its own oil resources, all petroleum requirements are met by imports. The cost of these imports is already high -- about US $65 million in 1994/1995 -- and will increase with increased consumption. Given the importance of adequate energy supplies for economic growth, and the substantial impact of oil imports on Uganda's balance of payment, providing incentives for improved efficiency in supply is critical. With the removal of controls on foreign exchange and petroleum prices in 1993 and 1994 respectively, the Government has already provided incentives for supply rationalization. Nevertheless, to ensure long-term competitive and environmentally sound development of petroleum operations, a number of issues require further consideration. These include:

- ***Cost-Effective Supply Strategy.*** Ensuring that petroleum products are supplied at the lowest possible cost while assuring a reasonable degree of supply security;
- ***Competition in Supply.*** Ensuring adequate competition in the marketplace through price and product quality monitoring;
- ***Strategic Stocks Storage: Safety and Management.*** Improving the safety and environmental management at the Jinja storage facility and choosing the most efficient arrangement for the management of strategic stocks;
- ***Government Ownership in Oil Companies.*** Reducing potential conflict of interest by Government ownership in oil companies.

Cost-Effective Supply Strategy

8. In a liberalized and competitive petroleum market, such as Uganda's, the oil companies are expected to minimize their costs by selecting the most cost-effective supply modes. However, in the interest of consumers, the Government should ensure that the cost-effectiveness criteria is not compromised because of market failures. To this end, the Government should compare the costs of different supply modes and encourage the oil companies to adopt the most beneficial strategy and to make the required investments. This strategy should be balanced with an assurance of security of supply. The Energy Assessment mission carried out a preliminary examination of three alternatives to determine the least-cost supply mode to meet the forecast demand. The

analysis indicated that the least-cost mode is a two-route supply arrangement involving: (i) for Kenya sourced products: pipeline to Kisumu and self-propelled barges to Port Bell; and (ii) for Tanzania sourced products: a continuation of existing arrangements. It actually provides three supply routes, because minor quantities could be supplied also from Eldoret by rail, and maintains use of the Uganda Railway Corporation's (URC) existing investments. Furthermore, the deployment of barges should add flexibility, as purchases will be possible anywhere on Lake Victoria. This alternative is also the least investment intensive of those studied, and reduces the risk of disruptions by diversifying supplies through at least two alternative routes. This point is important also in providing leverage in negotiating inland transportation tariffs. In the mission's view, a substantial portion of imports should be supplied through Tanzania for security reasons (25-30%), even though the Kenya Pipeline Company's (KPC) new pipeline from Eldoret to Kisumu and the lowering of the pipeline charge have improved the competitiveness of the Kenya route.

Competition in Supply

9. The elimination of foreign exchange and petroleum price controls should have spurred competition between the six oil companies currently operating in Uganda, and resulted in the lowest possible pump prices. However, two years after the liberalization, the experience is inconclusive. Therefore, the possibility of collusion both in procuring product offshore and supplying it to the Uganda market, or other failures that may distort prices should not be overlooked. The Government should ensure that a reasonable degree of competition is maintained so that an adequate share of the benefits of the deregulation are passed on to consumers. The Petroleum Division of the MNR has been given the dual responsibility of monitoring supply costs and the corresponding pump prices to determine if the desired forces of competition are at work. However, the MNR has neither enough institutional capacity nor adequate information to effectively carry out such monitoring at present. On MNR's request, therefore, IDA has agreed to provide technical assistance to implement a price monitoring system, under the energy component of the Third Power Project (Cr.2268-UG). MNR should proceed expeditiously in procuring the required technical expertise to design an effective monitoring system and to train MNR staff in its implementation. In addition to price monitoring, the Government should also oversee that the quality of products sold in the country conforms to established standards. Effective enforcement mechanisms should be examined as part of the design process for the monitoring system.

Strategic Stocks Storage: Safety and Management

10. **Safety**. While good safety and environmental management practices are generally followed in petroleum operations, and while environmental concerns are not a major constraint on activities in the sector, there are areas where environmental management could be improved. The Jinja strategic storage facility emerges as requiring the most urgent attention. At present, the operation of the facility is clearly a hazardous undertaking. Its fire protection capacity is minimal and because the facility lacks oil-spill

response and handling equipment, any spillage in loading or unloading, tank failure, earthquake, lightning, faulty truck or simple accident could cause a major problem. Not only are the plant personnel at risk, but the tanks, their contents (current replacement cost of the products is US$ 4.4 million), and possibly the surrounding area, could be victims of a possible accident.

11. To mitigate the risk of a major environmental or safety emergency, a complete rehabilitation with emphasis on installing adequate fire protection and oil-spill response facilities should be carried out. To minimize safety risks during the rehabilitation, which could take up to 18 months, all the storage tanks have to be emptied by selling off the entire inventory of products, a move which would also provide funding for the required works.

12. However, it is not sufficient to deal with the environmental management issues of the Jinja facility in isolation. Rather, the Government should carry out an analysis of the overall framework for rationalizing the management and operation of strategic stocks. At present, the Jinja facility is not operated efficiently, product losses, for instance, are unacceptably high, and product turnover is haphazard. This raises the issue whether a change in the management of the strategic stocks is required. Two alternatives emerge as worthy of further analysis: (i) management of Jinja by the oil companies; and (ii) incorporating strategic stocks into oil company storage.

13. **Management of Jinja by Oil Companies**. Government ownership and operation is often justified on the grounds that the Government needs to control the country's emergency stock. However, inevitably, during a supply emergency, the Government would have to co-operate with the oil companies to mitigate the problem and to administer any emergency allocation plan. The main argument against Government operation is that it requires the Government to build up its own capacity in an area where the private sector already has adequate expertise. This includes staff who are well-trained in oil terminal operations, acceptable standards of safety maintenance, fire protection and oil-spill response; as well as knowledge and experience of the oil business, ranging from oil accounting, to loading-rack operations, to checking product quality. The oil companies already have the required expertise available in Uganda and can obtain additional technical support from their parent companies when needed.

14. If the management of the strategic stocks is provided by the oil companies, the storage facilities can be owned either by the Government or by the oil companies. Under the current supply arrangements (Port Bell is the main receiving terminal) the Jinja facilities may be too poorly located for the oil companies to desire ownership (about 80 km from Kampala). However, when new product tankage needs to be build, any alternative locations should be compared to rehabilitating and converting the Jinja facility for commercial purposes. The "sunk-cost" in this facility could compensate for the higher transportation costs to Kampala, and make the facility appealing to the oil companies. Should the conversion not be feasible, but the Government decides to

maintain the Jinja facility as a storage for strategic stock, the most efficient mode of operation appears to be a leasing arrangement with a consortium of the oil companies.

15. **Incorporating Strategic Stocks into Oil Company Storage**. In some countries, dedicated strategic storage facilities have been abandoned in favor of using the existing oil company terminals to provide storage for strategic stock. The oil companies carry a certain amount of stock above their operational requirements, for which service, they are reimbursed for the additional working capital as well as for a portion of product loss and operating costs. As additional facilities are required, the companies build them and are allowed a fair return on their investment.

16. The Government should carefully examine the feasibility and cost-effectiveness of incorporating strategic stocks into existing oil company storage.

Government Ownership in Oil Companies

17. At present, the Government owns 50 percent of Agip and Total, which together have a 30 percent market share. Because sales to the large parastatals are usually based on bid tenders from the oil companies, there is a perceived conflict of interest by having a Government interest in the oil companies. The Government should consider divesting its holdings.

C. ELECTRICITY

18. Much has been done to bring the power sector back from the depths to which it had fallen during Uganda's years of civil strife. Unfortunately, the results on the institutional side have been far less satisfactory than on the physical side. Although improvements have been made, UEB remains inefficient, provides poor quality service and is still in precarious financial condition, unable to earn a profit, service its debts or contribute significantly to meeting its investment needs. Moreover, electricity is currently available to only about 5 percent of the population; the great majority of the people are either not within reach of the electricity system, or cannot afford the service.

19. In the pursuit of strengthening the power sub-sector's contribution to economic and social development - to meet the energy needs of a growing economy and provide more of the population with the benefits of electricity - the following issues must be addressed:

> ***Institutional change*** -- Establishing institutions that operate efficiently, provide high quality service and are financially sound;
>
> ***Private Sector Participation*** -- Making greater use of the resources of the private sector;

System Development -- Choosing a least-cost path for expanding system capacity to meet the needs of a growing economy and take advantage of export markets;

Extending Electrification -- Widening access to electricity by opening the way for non-grid connected conventional and non-conventional sources of supply, and extending the grid where viable.

Institutional Change

20. The need for change seems most pressing in two areas: (i) sub-sector organization, particularly concerning the relations between the government and the operating utility; and (ii) addressing UEB's operational and financial difficulties, the major part of which originates from the distribution and commercial functions.

21. **Sub-Sector Organization**. The establishment of a new relationship between the Ministry and UEB, based on arm's-length regulation of the utility's operations and finances, could do much to inject a measure of autonomy, commercial orientation and accountability into the sub-sector. The regulation of operations and tariffs would be the most crucial components of the new relationship.

22. The twin keys to successful operations regulation are the establishment of credible performance targets and the maintenance of accountability for the achievement of these targets. One way of meeting these requirements is through the use of performance based management contracts. Such contracts contain not only performance targets but explicit reciprocal obligations on the part of the regulator (government) to, for example, allow tariff increases, and obtain foreign loans if the enterprise performs as agreed. The regulatory mechanism must ensure that tariffs are (i) regularly reviewed and (ii) adjusted in accordance with sound economic and financial criteria. The choice of criteria for tariff adjustment may be less important than the establishment of a transparent and automatic process for their application.

23. **Strengthening UEB.** UEB's operational and financial problems lie largely in the areas of distribution and commercial operations. UEB also suffers frequent system breakdowns due to problems in the rehabilitation and maintenance of the generation and transmission facilities. While UEB now seems to be moving in the right direction to address these problems, the slow progress and uncertain outcome of UEB's ongoing efforts raise the issue of whether greater institutional change is required. Three change scenarios seem particularly worth exploring: contracting out UEB's distribution and commercial operations to a management firm; establishing a new distribution company separate from UEB; and contracting out the whole UEB to a management firm.

24. Contracting Out Distribution and Commercial Operations. This would involve contracting with a qualified firm to manage all or a part of UEB's distribution and

commercial operations. The principal advantages of contracting out are: it provides a means of putting operations into the hands of new and experienced managers with responsibility for change; signals an end to business as usual; and facilitates the introduction of changes (e.g., in staffing) that would have been difficult to make otherwise.

25. Establishing a Separate Distribution Company. Creating a new utility for distribution is a more radical option but one which perhaps offers the best means of breaking with the past and creating an institutional environment conducive to change. Transferring responsibility for distribution and commercial operations to a new, specialized enterprise, would create a dedicated institutional base for reducing losses and improving the quality of service, expanding the distribution system along rational lines, and improving billing and collections.

26. Contracting out the whole UEB. While contracting out the distribution and commercial operations to private management or establishing a separate distribution company would have the potential of addressing key financial problems, these measures would not address problems in the operation, maintenance and development of the generation and transmission systems. In addition, the major drawbacks of creating a separate utility are that breaking up existing institutions and creating new ones is never easy; the transition would involve difficult issues (e.g., the valuation and transfer of assets) that would have to be carefully worked out; and the separation of distribution from generation and transmission, in a system as small as Uganda's could potentially involve the loss of economies of scale and encumber coordination between the distribution and generation/transmission functions.

27. Moreover, putting the distribution - a core function - in the hands of others, is something which is very difficult for any utility management to contemplate. The 1995 consultant study recommended against contracting out for this reason, and also because it "...would be premature for UEB to decide on any contracting-out option until it has modernized its system, procedures and controls ...in order to put these activities on a sound, efficient and controlled basis." However, this view appears to beg the basic question of UEB's ability to "heal itself" in the absence of the sort of change that would be involved in contracting out.

28. Therefore, it would appear more realistic to consider contracting out the whole UEB to a management firm or consortium. This approach would help avoid potential coordination costs between the distribution and generation/transmission functions. It would also address comprehensively all managerial, operational, and development planning problems of UEB; and at the end of the contracting out period, give to the Government, a solid information base to decide on the best institutional arrangements for reforming the power sub-sector.

Private Sector Participation

29. The power sub-sector clearly needs a great deal of technical, managerial and financial help. Other developing countries in similar circumstances have been turning increasingly to the private sector for a variety of contractual services, financing, construction and operation of projects.

30. **Provision of Services**. In addition to contracting out the management of specific functions where UEB's performance is most in need of improvement, there are a wide range of ways in which Uganda can draw more heavily on the private sector for critical services. At one end of the spectrum lies the possibility of private sector management of the entire UEB operation under contractual arrangements, as discussed earlier, and as has been done elsewhere in Africa. Toward the other end, lie the more limited, traditional services provided by the private sector such as: (i) employing consultants in line as well as advisory positions to fill key skills gaps; (ii) twinning arrangements; (iii) making greater use of contractors for operations that are now carried out by force account; and (iv) turning over UEB's non-core activities (e.g., the provision of staff housing) to the private sector.

31. **Independent Power Projects (IPPs).** Projects in which private investors, either alone or in conjunction with existing public utilities, finance, build, own and operate generating plants are an increasingly important phenomenon in many developed and developing countries. In most cases, private investors provide equity and debt financing on a project or limited-recourse basis, relying on the prospective earnings of the project itself to meet operation and maintenance expenses, service debt and provide a return on equity. Export projects are something of a special case. Since they earn foreign exchange, they can be set up on an "enclave" basis, which promotes financial sustainability by allowing earnings to be deposited abroad in escrow-type accounts from which direct payment is made to suppliers and creditors and to meet other obligations. Such an arrangement is usually very attractive to investors. Uganda has already moved towards IPPs when it entered into negotiations with a private investor group for the Bujagali project. To set up Bujagali along the lines of an export project implies the need for a trilateral relationship, with Uganda providing the site in return for royalties and taxes on the IPP earnings; Kenya providing the market under the terms of a power purchase agreement, presumably backed up by performance guarantees; and the IPP agreeing to finance, construct and operate the plant.

32. To find out whether Uganda can in the near term obtain private investment in the power sector will not be easy. While the necessary institutional arrangements need not be fully in place before trying to attract IPPs, certain minimum conditions must be established. Even when this is done, the process of stimulating investor interest, negotiating project arrangements and raising financing is likely to be difficult and time consuming. However, given the pressing need for capital, technology and management, this is a process well worth initiating. As a first step, Uganda should clearly and explicitly commit itself to private participation by revising the Electricity Act to end

UEB's monopoly status and clearly open the door to private investors, domestic as well as foreign. To this end, the Government has already shown decisiveness by initiating the revision process. While the new legislation may contain minimum conditions for IPPs, it probably should not go beyond this since the Government will need a maximum of flexibility in negotiating financial and other terms on a project-by-project basis.

33. **Approach to Increasing Private Sector Contribution.** In conclusion, the following actions could form elements of a strategy to maximize the contributions from the private sector: improve UEB's financial situation; introduce management contract for UEB; revise the Electricity Act; create a separate regulatory body with "teeth"; contract out UEB's staff housing, pole manufacture, and distribution line construction activities; identify generation projects for IPPs to be bid on a competitive basis; evaluate feasibility of leasing and/or contracting out distribution areas; prepare bidding documents; and strengthen the Government's capacity to evaluate private sector proposals.

System Development

34. Institutional change is a necessary but not sufficient condition for improving the efficiency and reliability of the power system to meet the growing needs of the economy. Advantage must be taken of the long-term potential for developing a major export industry based on one of Uganda's principal resources, hydro-power.

35. **Meeting Uganda's Needs**. The power system has been running nearly flat out during the past 2-3 years. As already discussed, contracting out parts or the whole UEB could inject a measure of efficiency to ease the current constraints in generation capability. In the meantime UEB should mount a major stop-gap effort to: (i) drastically increasing revenue collection (e.g. pre-payment meters) and reducing accounts receivable (equivalent to almost one year's billings); (ii) reducing non-technical losses by completing the physical inventory of customers and updating the customer database; and (iii) reducing technical losses through a concerted program to strengthen the distribution network and its maintenance and operation. However, definitive relief from current capacity constraints will only come with the commissioning of the first phase (2x40 MW) of the Owen Falls Extension, scheduled for 1998. The need for further additions to capacity can be illustrated in terms of two simple load growth scenarios: (i) 7.5%, a "high" growth rate but one somewhat lower than the rate at which total supply increased during the 1986-91 recovery period; and (ii) 5.5%, a "low" growth rate reflecting the 1992-94 rate of increase in total supply.

36. These scenarios indicate that Uganda could need additional capacity before the year 2000, just to satisfy the requirements of the domestic market. Capacity could be expanded at least cost through the installation of three additional units at the Owen Falls Extension, which has been designed to accommodate five 40 MW units. However, this appears to require a change in the way water is managed at Owen Falls in order to ensure that the flow is adequate for the additional units. Negotiations for the

revision of the present "Agreed Curve" operating arrangements with the other riparians should be urgently pursued. The generation Master Plan is expected to review these and other options on a least-cost development basis.

37. **Export Potential.** Uganda's vast hydropower potential could be developed for export markets, since there is not likely to be a need for a large-scale hydro development for the domestic market in the next 10 years or so if the Owen Falls Extension is expanded to full capacity. Though UEB now exports about 25 percent of its total generation, Uganda's future as an energy exporter could be much brighter. To realize this potential, in addition to securing a change in the Agreed Curve, Uganda will need to: (i) reach agreement with Kenya or other neighboring country on the purchase of an economic quantity of electricity at an economic price; (ii) identify a least-cost site for development; and (iii) make satisfactory arrangements for the construction, financing and operation of the new plant. However, UEB's financial weakness and operational shortcomings mean that Uganda's best hope of developing its export potential appears to lie in enlisting the assistance of the private sector, which has already shown interest in developing the Bujagali site.

Extending Electrification

38. The benefits of electricity are today available to only a small fraction of the population living in the capital and the larger towns. The requirements for extending service are best viewed by distinguishing between "urban" and "rural" electrification -- i.e., between areas already served by the grid or located close to it, and areas remote from the grid that are unlikely to be reached by it in the foreseeable future.

39. In urban areas the basic task is one of strengthening and extending the existing distribution network. While UEB has been increasing the number of connections to its system, this has often been done in an unplanned way; a technically and economically sound distribution rehabilitation and expansion plan covering, say, a five year period should be prepared.

40. The electrification of rural areas remote from the grid, where the bulk of the population live, is quite a different matter. It has been neglected for decades, although with increasing disposable incomes, there exists considerable scope for electricity supply. It is, however, unrealistic to think that more than a fraction of the rural population could be reached by the conventional, extend-the-grid approach. A more promising course is to rely, instead, on "alternative", "non-conventional" or "complementary" approaches to electrification. These include small diesel or gasoline generators for private or public supplies, and car batteries to provide small amounts of electricity for lighting, radio, and even television, as well as the use of photovoltaic technology and other renewable energy systems for domestic and other small scale uses. The private sector has already taken a lead: substantial numbers of solar photovoltaic systems and diesel- and petrol-driven generators have been imported into Uganda and installed in various parts of the country to provide electricity to households, industries and commercial establishments. Further

opportunities exist for the establishment of decentralized power systems based on small-scale hydropower, sales by auto-generators (such as sugar and tea factories), and photovoltaic technology. These systems -- i.e. small integrated power systems that are not connected to the grid -- may be an option for larger load centers which are located away from the grid. There is a market niche for private investment, both domestic and foreign, to set up these types of community-based generation and distribution systems.

D. Renewable and Traditional Energy

41. Uganda is richly endowed with renewable energy resources. These include plentiful biomass supplies, extensive hydrological resources, favorable solar conditions, and large quantities of biomass residues from agricultural production, among others. With the exception of biomass, Uganda utilizes only a fraction of its renewable energy resource potential. Considerable Government, donor, NGO and private sector interest has been shown over the past fifteen years to develop Uganda's renewable and traditional energy sector. The results have been meager. Much more concerted and coordinated efforts should be carried out to develop the efficient use of Uganda's renewable energy resources.

42. The review of renewable energy demand and activities in Uganda highlights three major issues:

- ***Coordination and Rationalization of Programs***. The proliferation of donor-driven, uncoordinated, often ad hoc projects and programs in renewable energy in Uganda has not had any major positive effect on the country's energy balance or environment;

- ***Biomass Supply and End-Use Efficiency***. Biomass energy is of far more importance to Uganda's economy than previously noted, particularly in terms of industrial energy, however, the efficiency of both end-use and production could and should be improved;

- ***Biogas Program.*** Recommending an end to biogas programs due to the present economic constraints of biogas as a viable energy option.

Coordination and Rationalization of Programs

43. Numerous programs with few discernible results have caused cynicism among Ugandans, the Government, and donors as to the potential of traditional and renewable energy. Its actual contributions to the country's development remain unclear, largely due to the lack of coordination and information-sharing of widely dispersed, isolated projects lacking fora to share project information such as project goals, strategy, planning, execution, lessons learned, and actual outcomes. Much duplication of effort, ignorance of previously established baseline information, and the proverbial "reinvention

of the wheel" has resulted from this state of affairs. This is unfortunate, as traditional and renewable energy can contribute substantially to economic development in Uganda.

44. It is therefore suggested that all previous energy projects and activities be reviewed, inventoried, and analyzed in an in-depth study. Stock should be taken of all activities in the traditional and renewable sector to rank results and their outputs. The objective of this exercise should be to establish some objectively verifiable indicators to help form a rational base for future activities by ranking and prioritizing projects and investments, on which basis donor support can be channeled. The study should compare in-country projects and programs to similar studies and projects already enjoying regional success, as well as the comparative successes of intra-country activities. The private sector, particularly in the charcoal production, agro-industry and photovoltaic sectors, should be invited, to contribute their expertise. This study could then provide the Government and all interested parties with a framework to encourage the rational, economical and environmentally sustainable development of traditional and renewable energy in Uganda.

45. The above activity would also contribute to building the well needed analytical capability at the MNR for policy and strategy formulation in the areas of traditional and renewable energy.

Biomass Supply and End-Use Efficiency

46. Firewood, charcoal and crop residues are the most widely available and exploited energy sources in Uganda. They provide almost all of the energy used to meet the basic needs of cooking and water boiling in the rural residential sector and is the fuel of first choice in many industries and commercial establishments. This can be expected to continue for many years to come given the high price of modern energy sources, and the limited and unreliable supply of electricity.

47. Uganda has the physical and agro-ecological potential to supply biomass at current levels of demand. However, much of the supply is in remote areas far from urban centers, and agricultural encroachment tends to reduce the country's forest stock. Preliminary NBS (National Biomass Study) results show that there is not sufficient annual yield of woody biomass to meet demand in those regions that contain major urban centers, thus, fuelwood needs to be transported from other regions at a significant cost. In an effort to reduce the cutting of forests in the face of an increasing biomass demand, an effort should be made to create an enabling policy framework to provide incentives for increased private sector farm tree planting. This would not only produce wood and wood products for sale but would also help increase agricultural productivity. Some initiatives are already underway, but increased efforts to clarify land ownership and tenure rights are crucial for farmers to make long-term investments in agriculture and silviculture.

48. Efficiency could and should be improved in biomass end-use. Industry has already shown a willingness to move towards more energy-efficient utilization and

the Government can accelerate these trends through catalyzing the provision of investment credit, technical assistance and training, and imports of energy-efficient equipment. In the household and commercial sectors, the Government needs first to analyze the results of previous work in the improved stove area, and focus on the most enthusiastic and receptive groups. Experience of stove programs around the world indicate that in addition to a rapid payback period, which appears to be necessary for successful dissemination of stoves, successful efforts are those that maintain consistent, long-term, and high level commitment to stove manufacture and dissemination, and pay attention to targeting markets, and design stoves that consumers actually want. Improving the quality of stoves would also contribute to reducing indoor pollution, which affects the health, particularly, of women and children.

49. With respect to charcoal production, proven techniques exist to dramatically improve efficiency -- by improving kiln construction, firing, and tending practices -- if only producers were organized so they could be reached more easily with new methods. Improvement can be obtained also from existing earthen kilns by training charcoalers in improved kiln management practices, which would increase yields from each charge and raise the charcoalers' incomes.

Biogas Program

50. Biogas remains an expensive energy option. Its applications will remain experimental so long as less expensive fuelwood is available. Since there is no clear demand from consumers for biogas, and since small and medium sized biogas applications will not be able to compete financially in the marketplace against wood and electricity, the Government should not extend its biogas program.

Uganda Energy Assessment

Summary of Recommendations

Priority Issue	Recommendation
Petroleum Sub-Sector	
Supply Strategy and Investment Requirements	Analyze alternative supply routes and determine the least-cost mode. Encourage oil companies to maintain two supply routes (according to mission's analysis, self propelled barges from Kisumu to Port Bell would provide a cost effective alternative). Oil companies to build additional product tankage to meet future demand.
Competition in Supply	Implement a petroleum product price and quality monitoring system.
Strategic Stocks Storage: Safety and Management	Improve environmental management at the Jinja strategic storage facilities. Carry out a comprehensive evaluation of how to improve operational management of strategic stocks including the following options: (i) incorporating strategic stocks into oil company storage; (ii) oil company ownership of the Jinja facilities which could be converted into combined operational and strategic stock storage; and (iii) leasing the Jinja facilities to the oil companies.
Government Ownership in Oil Companies	Examine means to reduce possible conflict of interest by divesting Government ownership in oil companies.
Power Sub-Sector	
Institutional Change	Establish an arm's length relationship between MNR and UEB to increase commercial orientation in UEB's operations. Strengthen UEB by contracting out distribution and commercial operations, or creating a separate distribution company, or contracting out the whole UEB through management contract.
Private Sector Participation	Make greater use of the resources of the private sector through management contracts, twinning arrangements and independent power producers. Revise the Electricity Act to end UEB's quasi regulatory function and create a separate regulatory body. Identify generation projects for IPPs to be bid on competitive basis. Strengthen Government's capacity to evaluate private sector proposals.

Priority Issue	Recommendation
System Development	While new institutional arrangements are finalized, implement stop-gap measures to reduce: (i) technical losses through strengthening distribution network and its operation and maintenance; and (ii) non-technical losses by drastically increasing revenue collection and reducing accounts receivable. Increase capacity in accordance to least-cost expansion plan. Begin discussions with potential purchasers of Ugandan electricity to capitalize on export potential.
Extending Electrification	In urban areas, prepare a distribution rehabilitation and expansion plan. In rural areas, promote use of alternative and renewable energy options, such as mini-hydro, solar, and battery recharging. Promote decentralized power systems to be build, owned and operated by co-operatives and/or domestic or foreign investors.
Renewable and Traditional Energy	
Coordination and Rationalization of Programs	Review all previous activities to identify critical success factors and rank results and outputs to help form sound basis for future programs.
Biomass Supply	Create an enabling policy framework to provide incentives for increased private sector farm tree planting.
Improve Efficiency in Charcoal Production	Organize charcoal producers and provide them with training and skills in modern production techniques.
Improve Stove and End-Use Efficiency	Identify success projects in Uganda and abroad for replication and promote the production of low-cost efficient stoves that consumers really want.
Biogas Program	End non-viable program.

1. THE ECONOMY AND THE ENERGY SECTOR

1.1 Uganda's weak economy and poor social indicators are the legacy of nearly 15 years of political turmoil and economic decline. Since 1987, the Government has been implementing an economic reform program supported by a large number of donors. The program is promoting prudent fiscal and monetary management, improving incentives to the private sector, reforming the regulatory framework, and developing human capital through investment in education and health. Economic recovery and stabilization have been successful and this hard-won stability has been maintained for the past three years. However, the stability is precarious, and a continuation of good policies and further improvement are therefore required.

1.2 Economic growth has picked up since 1987. GDP grew at an average annual rate of about 6.4 between 1987 and 1995. In 1995, the per capita income had risen to about US $250. Agriculture, which makes up half of the GDP, dominates the growth figures, employs more than 80 percent of the labor force and accounts for virtually all exports, mainly coffee and tea. The industrial sector, which includes agro based industries, such as coffee, cotton, sugar, beverages, as well as manufacturing industries has been growing rapidly. The share of industry in GDP is around 14 percent. The service sector makes up the balance of the GDP.

1.3 Uganda's 18 million people are largely rural but urbanization is likely to accelerate with economic growth. Provision of adequate infrastructure services, including power and energy is a key to both urban and rural growth. To this end, the Government is focusing on a major effort build up its infrastructure which suffered significant damage during the years of political turmoil.

A. THE ENERGY SECTOR AND THE ECONOMY

1.4 **Recent Economic Developments.** Over the last few years, the Government of Uganda has been successful in stabilizing the economy and introducing reforms under its Economic Recovery Program. In fiscal year 1995, the GDP growth rate was about 10 percent, thus substantially exceeding the annual population growth rate of about 3 percent. The exchange rate was unified and the auction system removed in November 1993. With the liberalization of petroleum prices in January 1994, all price controls have been eliminated. The Government's efforts to control inflation have also been successful and the annual inflation rate fell to 6.5 percent in 1995, from nearly 60 percent in 1992. The dollar inflow which followed the foreign exchange liberalization, partly resulting from the improved coffee export earnings and increased investments, caused a rapid appreciation of the Uganda Shilling, which rose to 900 to the dollar in February 1994. By March 1996, the Shilling had depreciated to about 1,000 to the dollar.

1.5 **Energy/Economy Linkages**. The energy sector plays a critical role in the development of the economy. It is a major component of the country's infrastructure, and supports economic activity and social development. It also contributes significantly to financing public expenditures as petroleum taxes provide about 30 percent of total fiscal revenues. Revenue from electricity sales taxes contributes around one percent of total revenues. Energy sector does not currently contribute significantly to exports; electricity sales to Kenya are negligible and amount to only US $1.5 million -- less than one percent of total exports -- but could be much higher and significantly improve the trade balance. Assuming, for instance, that the Kenya tariff was re-negotiated at US cents 5 per kWh and given the current export volume, the annual earnings would increase to US $14 million.

1.6 On the other hand, the energy sector draws on the country's resources, using foreign exchange to import petroleum products and equipment, and also to service its external debt, especially in the power sub-sector, which also uses a large portion of the project aid Uganda receives. The oil import bill in 1994/1995 was about US $65 million, which was equivalent to 15 percent of the value of earnings from merchandise exports. About one third of total import support funds (grants and loans) was used to pay the oil import bill. Assuming an annual GDP growth rate of 6 percent for the next few years and the industrial sector growing at about 9 percent, petroleum imports are to increase 7-8 percent per year, implying a commensurate rate of increase in the oil bill.

1.7 **Energy Sector Investment**. The Rehabilitation and Development Plan for 1993-1996 included US$232 million for energy sector investments. This was 15 percent of the Plan total. According to the Plan, donor assistance provided US $216 million or 93 percent. Rehabilitation, expansion and maintenance of the economic infrastructure were high priority in the Plan, along with the promotion of new investments. The Government's medium term public investment strategy relies on: (i) concentrating investment resources on those activities/sectors in which Government must play a leading role, such as the provision of public/social services and the elimination of infrastructure bottlenecks (such as those in transport, energy and marketing facilities); (ii) ensuring that expenditures within the priority sectors are cost-effective; and (iii) withdrawing from activities which can be carried out by the private sector. Table 1.1 summarizes the 1993-1996 energy sector investments.

Table 1.1: RDP 1993-1996 - Energy Sector (US$ million)

	1993/94	1994/95	1995/96	Total
Tot. Energy Projects	59.76	80.38	91.57	231.71
Power II				
Donors	15.2	7.1	-	22.3
Power III				
Donors	23.0	48.3	64.2	135.5
UEB	-	3.3	8.2	11.5
Urban Power Network Rehab.				
Donors	7.0	12.7	13.2	33.0
UEB	2.8	1.0	1.0	4.8
Masaka-Mbarara Transm. Line				
Donors	6.6	2.2	-	8.8
O. Falls-Kampala Transm. Line				
Donors	3.3	5.7	5.0	14.0
Grid Extension to Tanzania				
Donors	1.7	-	-	1.7
Biogas Energy Devt. Program				
Donors	0.2	-	-	0.2
Selected Mining Projects				
Petrol. Exploration Promotion				
Donors	0.7	-	-	0.7
MNR	0.1	-	-	0.1
Geothermal Energy Project				
Donors	0.4	-	-	0.4
Selected Forestry Projects				
Biomass Study Phase II				
Donors	0.1	0.2	0.1	0.4

B. ENERGY DEMAND AND RESOURCES

1.8 **Energy Demand**. Biomass, primarily fuelwood is the main energy source in Uganda (see Table 1.2). Biomass supplies thirty times as much energy (on a final energy end use basis) as petroleum and electricity combined, and three and a half times as much final energy to both the industrial and commercial sectors as electricity and petroleum combined. The use of modern energy has been estimated at about 0.02 tons of oil equivalent (toe) per capita, which is low even by the standards of sub-Sahara Africa. The per capita use of modern energy in Tanzania and Kenya, for instance, is 0.04 and 0.1 toe respectively. Access to modern energy sources is limited to urban areas. On average, only 5 percent of the population have access to electricity: less than 2 percent in rural areas, and about 40 percent in the capital city of Kampala. Electricity generation is predominantly hydro (160 MW peak). About 400 million cubic meters of petroleum products are imported annually (See Annex 1.1)

Table 1.2: Final Energy Demand (Effectively Utilized Energy): 1994 (in giga joules/GJ)

	Biomass	Petroleum	Electricity	Total	
1. Household					
Urban	3.3	0.1	0.9	4.3	2.8%
Rural	130.7	0.3	0.1	131.1	85.0%
Sub-Total	134.0	0.4	0.9	135.4	87.8%
2. Industrial	7.1	0.9	1.2	9.2	6.0%
3. Commercial	4.3	0.5	0.6	5.4	3.5%
4. Institutional	3.4	0.2	0.3	3.8	2.5%
5. Transport	0.0	0.4	0.0	0.4	0.2%
Sub-Total	14.8	2	2.1	18.8	12.2%
Total	148.8	2.4	3.0	154.2	100.0%
	96.5%	1.5%	2.0%	100.0%	

Source: Mission estimates.

1.9 **Energy Demand Projections.** The Energy Assessment Mission developed two energy demand forecasts: a Base Case and a High Case. In the Base Case, assuming an annual GDP growth rate of 6 percent, demand for electricity and petroleum is projected to increase at around 6 - 7 percent per year. The consumption of traditional energy is expected to increase at a rate equaling population growth -- about 3 percent per year. Table 1.3 shows the Base Case Forecast and Annex 1.2 provides assumptions and detailed Base Case and High Case forecasts.

Table 1.3: Energy Demand Forecast (% annual growth, Base Case)

	1990-1995	1996-2005	1990-2005	1992-2012
Total Energy Demand	3.0	3.0	3.0	3.0
Electricity	8.0	6.2	6.8	6.3
Petroleum Products	2.1	6.8	5.2	6.9
Woodfuel	2.9	2.9	2.9	2.9

Source: Annex 1.2

1.10 **Energy Resources.** Uganda is richly endowed with renewable energy resources but their utilization is low. These include plentiful biomass and hydrological resources, favorable solar conditions, and large quantities of agricultural residues. Uganda's comparative advantage in modern energy resources is hydro power, which is concentrated on the White Nile River, as it descends from lake Victoria. The total hydro potential is equivalent to at least 2,000 MW of which only 150 MW has been developed at the Owen Falls plant (commissioned in 1954). Geothermal resources have been identified in the west of the country but their economic viability is not yet known. No petroleum resources have been discovered. There is no coal and, although peat exists, the quantities have not justified exploitation. Woodfuel and other biomass are plentiful in many areas of southern Uganda, but localized deforestation is affecting some peri-urban regions, which have to import wood from the surplus regions. Given the low per capita

income, switching to modern, commercial fuels such as kerosene and LPG is not affordable for most households at present.

Table 1.4: Uganda's Energy Resources

Source	Total Resources		Primary Use	
	Toe x 10^6	%	Toe x 10^6	%
Fuelwood	5,023	85.1	3,995	88
Crop Residues (1)	686	11.6	514	11.3
Coffee Husk	7	0.1	5	0.1
Hydropower	188	3.2	27	0.6
TOTAL	5,904	100.0	4,541	100.0

(1) Including Bagasse

Source: Mission Estimated based on National Energy Balance, 1990 (See Annex 1.1).

C. ENERGY SECTOR ORGANIZATION

1.11 The Ministry of Natural Resources (MNR) is responsible for the management and development of the country's water, forests, energy and mineral resources. Within the energy sector, MNR sets broad sector policies and strategies and currently supervises and regulates the power and petroleum sub-sectors. As part of the civil service reform program, MNR has been reorganized and its functions redefined to improve effectiveness.[1] However, the pace of the restructuring should be accelerated and the MNR should continue to build its capacity to ensure effective policy making and oversight of the energy sector. In particular, the MNR should strengthen its capacity to monitor operations in the petroleum sub-sector, to ensure commercial orientation in power sub-sector operations, and to promote energy conservation and efficiency programs. In addition, the Government should increase its capacity to evaluate options for private sector participation.

1.12 The state-owned Uganda Electricity Board (UEB) is responsible for power generation, transmission and distribution, and is the largest state corporation in the country with about 3,400 employees. The distribution of petroleum is in the hands of sister companies of six international oil companies and one local company.

[1] The Directorate of Mineral and Energy includes three departments: Energy, Geological Surveys and Mines, and Petroleum Exploration. The Department of Energy, headed by the Commissioner for Energy, includes four divisions: Petroleum Supply, Electric Power, New and Renewable Energy, and Energy Efficiency, each headed by an Assistant Commissioner. Issues related to the management of gazetted indigenous forests, partly for woodfuel production, are dealt with by the Forestry Department, which is located within the Directorate of Environment.

D. ENERGY AND ENVIRONMENT

1.13 Concerns about the rapidly degrading environment and the need for prudent natural resource management led the Government to launch the preparation of a National Environment Action Plan (NEAP) in 1990. The NEAP process identified, analyzed and is currently prioritizing environmental problems and opportunities and has developed a comprehensive national strategy for participatory, sustainable development based on sound environmental management. The NEAP programs focus on institutional capacity building particularly at the central and district level, training, legislative reforms, and awareness-building. They also include broadly defined projects in the areas of "resource productivity enhancement", "bio-diversity management", "environmental education" and "environmental health and pollution management".

1.14 In the energy sector, the efficient provision and use of energy can contribute importantly to environmental sustainability. This linkage is evident in both the traditional and modern energy sectors. Efficient and reliable distribution of modern energy reduces the need to over-cut forests for woodfuel; efficient end-use reduces the need to increase supplies. Also, the "lifeline" tariff for electricity can effectively target those lower income groups that are most affected by environmental degradation. On the other hand, the energy sector may also create environmental problems, through, for example, the development of energy resources, or through toxic emissions and wastes from petroleum..

1.15 A preliminary assessment of a wide range of potential environmental problems associated with the energy sector reveals that environmental issues are not generally a major constraint on activities in the sector. Uganda is fortunate in that, many of the environmental problems experienced elsewhere in the world have not yet reached significant levels. In setting priorities within the energy sector, the following considerations are relevant:

(a) in the past, air pollution has not received much attention. Although historical emission levels may not generate obvious problems, future emissions (especially of lead from petrol and sulfur and particulates from diesel) may become a problem.

(b) water pollution on Lake Victoria, especially the kind associated with potential catastrophic oil spills, would be a high priority if based solely on political criteria or on human safety concerns. From an environmental perspective, however, the ecological and economic impacts associated with ongoing dumping of untreated sewage and improper disposal of oily wastes is a significantly greater problem (see Annex 2.6).

(c) land degradation from energy sector activities is generally not significant, although environmental degradation from fuelwood gathering is often

politically perceived to be of significance. A greater environmental concern is land degradation from agriculture encroachment.

Possible environmental impacts associated with hydroelectric development are generally readily contained and, if re-settlement is limited, have little effect on other economic activities. The major issues associated with the possible regulation of water levels in Lake Victoria and of the Nile River itself are, for the most part, political in nature (see Annex 3.12).

2. THE PETROLEUM SUB-SECTOR

2.1 With continued strong economic growth, and the concurrent increase in petroleum demand, Uganda will have to ensure that adequate, reliable and affordable supplies are available to all sectors of the economy. Given Uganda's present low per capita petroleum consumption (17 kg), it is not unreasonable to assume that it would increase significantly as the economy modernizes. Since Uganda does not have its own oil resources, all petroleum requirements have to be met by importing finished products. The costs of these imports are already high -- representing some 15 percent of foreign exchange earnings in 1995 -- and will undoubtedly increase as demand increases. Given the importance of energy supplies on economic growth, and the substantial impact of oil imports on Uganda's balance of payment account, providing incentives for efficiency improvements is of vital interest to the economy. With the removal of controls on foreign exchange and petroleum prices in 1993 and 1994 respectively, the Government has provided incentives for supply rationalization. Nevertheless, to ensure long-term competitive and environmentally sound development of petroleum operations, there are a number of issues that require further consideration. These include:

- **Cost-Effective Supply Strategy and Investment Requirements**. Encouraging oil companies to maintain least-cost supply strategy while assuring a reasonable degree of security in supply.
- **Competition in Supply**. Ensuring adequate competition in the marketplace through price and product quality monitoring.
- **Safety and Environmental Management**. Reducing environmental and safety hazards in oil operations at lake Victoria and improving environmental management at the Jinja strategic storage facilities.
- **Management of Strategic Stocks and Government Ownership in Oil Companies**. Choosing the most efficient arrangement for the management of strategic stocks and reducing potential conflict of interest by Government ownership in oil companies.

2.2 While these four issues should be considered as the most important in the petroleum sub-sector at present, the following issues also deserve consideration:

- Illegal Imports
- Ethanol Blending Program
- Petroleum Exploration

Each of these issues will be discussed below, following a review of the salient features in the petroleum sub-sector.

A. THE PETROLEUM MARKET PLACE

2.3 **Recent Consumption Trends.** Petroleum products demand in Uganda is low compared to neighboring Kenya and Tanzania. According to preliminary official data, the total consumption was about 445 million liters in 1995. From 1984 to 1989, the consumption of petroleum products increased by an average of 8 percent per year. Then, from 1990 through 1992 consumption decreased by 8 percent annually, despite a rapid increase in the number of motor vehicles (to an estimated 50,000 in 1992) and an annual average GDP growth rate of about 5 percent. One reason for the declining consumption may have been the significant real price increases in 1988-90. Another reason may have been the omission of smuggled products in the official data -- estimated to make up as much as 10 percent of total consumption. It is also possible that the efficiency of fuel use has improved as new vehicles have been imported. Since 1992, demand has increased rapidly, and consumption in 1995 was some 30 percent higher than in 1994 (preliminary 1995 data). A significant increase in the consumption of aviation fuel appears to account for the growth. Annex 2.1 provides historical consumption data.

2.4 **Demand Projections.** The Energy Assessment Mission developed product demand forecasts for the period 1994-2010. These forecasts used the 1993 actual demand (including un-accounted for sales) as the base line and considered the annual GDP (6% and 7%) and population (3%) growth rates, and improvements in end-use efficiency as explanatory variables. The forecasts project petroleum demand to rise at an average annual rate of 6 to 8 percent. This implies that in 15 years the total annual demand could more than double from the current 400 million litres to more than 900 million litres, putting significantly increased pressure on the supply capacity. The Base Case and High Case scenarios are summarized in Table 2.1 below.

Table 2.1 Petroleum Product Demand Projections: 1994-2010
(million litres)

	Diesel	Fuel Oil	Gasoline	Kerosene	LPG	Av. Fuels	TOTAL
Base Case							
1994	99	17	140	33	1.3	25	315
2010	360	48	385	46	6	69	914
% growth rate p.a.	8.4%	6.8%	6.5%	2.1%	9.8%	3.8%	6.6%
High Case							
1994	101	17	141	33	1.4	25	319
2010	451	68	471	46	10	107	1153
% growth rate p.a.	9.9%	9.0%	7.8%	2.1%	13%	6.6%	8.1%

Source: Annex 2.2.

2.5 **Marketing and Distribution.** Product marketing and distribution is within the private sector. Six companies market products to consumers, of which one is an independet Ugandan: Shell (39% of market); Total (23%); Agip (9%); Caltex (12%); Esso (10%); and UPET (7%). The Government has a 50 percent stake in Total and Agip. The distribution system, including 287 retail outlets, has considerable excess capacity and

rationalization is underway, with a number of outlets having been closed recently. The service stations are in relatively good repair and the oil companies have either already made or are planning further improvements and upgrades. Shell and Total are the only marketers presently selling aviation fuel.

2.6 **Supply Channels**. The oil companies import finished products through two ports: Mombasa in Kenya (70% of supply) and Dar es Salaam in Tanzania (30%). The oil companies' respective offshore trading companies usually act as suppliers, except for UPET, who makes independent arrangements. Because of the relatively small size of the Ugandan market, the products are imported on General Purpose vessels (20-25,000 tons) on two-port discharge voyages; or in part-cargoes with other oil companies.[2] For the most part, the sister companies of the Uganda oil companies in both Mombasa and Dar es Salaam[3] provide storage terminals for the received products. From Mombasa, white products are transported by pipeline through Nairobi to terminals in Eldoret (about 110 km from the Uganda border) and Kisumu (on Lake Victoria, about 90 km from Ugandan border).[4] White products are transported further from Eldoret to Uganda by rail (10%) and by truck (90%), and from Kisumu by truck. Black products and LPG are transported from Mombasa by truck. From Dar es Salaam, both white and black products are transported to Uganda by rail; the wagons are loaded on a rail-ferry to cross Lake Victoria from Mwanza to Port Bell. From Port Bell and the Kampala terminals, oil companies truck products to local depots in the capital city region. Terminals in other parts of the country are usually supplied directly from Kenya and Tanzania (Annex 2.5).

2.7 There are two principal reasons to maintain the two supply routes. First, two routes provide diversification of sources; Uganda is land-locked and there has been past experience with disruptions of supply through Kenya. Second, two routes also provide a degree of competition, and should moderate the level of tariffs charged on the alternative route. Until recently, the landed cost of Tanzania-sourced products was some

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2 This type of ocean freight is slightly more costly than shipping products on one-port discharge voyages. However, this higher ocean freight cost (US$ 1.50-2.50/t before AFRA adjustment or an average of about US$ 3.00/t after adjustment) must be balanced against the lower cost associated with a smaller amount of working capital tied up in inventories. A calculation of the actual cost differences, shown in Annex 2.3., shows that at present there is estimated to be an advantage of 0.11-0.15 US cents/litre from using fully loaded GP vessels rather than using part-cargoes for the replenishment of products.

3 The exceptions involve the use of the Bulk Oil Terminal in Dar for UPET, Esso and sometimes Shell. Although the Shell-BP Tanzania company is 50% owned by Shell, it is operated by BP and is not totally used by Shell-Uganda. Esso uses Bulk Oil under a special arrangement whereby products are purchased from Bulk Oil CIF Kampala. This is done so that Esso does not have title to the products as they cross Lake Victoria by rail-ferry where there is a risk of oil-spill. UPET also uses the KOBIL Oil Company terminal in Mombasa.

4 The pipeline is owned and operated by the Kenya Pipeline Company (KPC). KPC requires that all products transported in the pipelines be owned by Kenyan companies. Consequently, at this time, the Kenyan sister companies of the Uganda oil companies must be in the supply chain. Detailed physical data on the Kenya pipelines and their terminals are shown in Annex 2.4.

1.1-1.6 US cents/litre (6%-9%) less than Kenya-sourced products. The condition of the Tanzania Railroad, its tank wagon capacity and the efficiency of Uganda's Railways Corporation (URC) will determine whether the Tanzania route can compete with the newly extended pipeline to Kisumu, especially as the owner of the pipeline, Kenya Pipeline Company Ltd. (KPC), has reduced its charges.

2.8 The Government operates a strategic storage facility at Jinja that has three 10,000 m^3 tanks, one each for petrol, kerosene, and diesel. The facility can receive products by rail and truck but can dispatch only by truck.

2.9 **Cost of Imports**. In 1995, petroleum product imports (preliminary data) cost about US $65 million, which is an 17 percent increase over 1994. Because of the high cost of petroleum and because the Government was concerned that the oil company traders were charging too much for their services, at least one study looked at the possibility of a centralized International Competitive Bidding system (ICB).[5] The study estimated that an ICB system could yield annual savings of about $3.8 million. However, the study may have overestimated the potential savings, because it did not address the possible risks of dependency on one supply route, nor the costs of operating the ICB. Moreover, the study was undertaken prior to the deregulation of pump prices and foreign exchange, two elements which are expected to reduce the costs. The Government therefore shelved the option of a centralized ICB system in favor of a liberalized market strategy to try to reduce supply costs.

2.10 **Prices and Taxation**. Pump prices of petrol, kerosene and diesel are high when compared to neighboring Kenya and Tanzania. The price in Kenya, for example, is less than one-half of that in Uganda. The retail prices in Uganda range from 4 to 5 1/2 times their CIF landed cost at the seaboard in Kenya and Tanzania. The principal reasons for the high prices are high inland transportation costs from the seaboard -- about one-third of the CIF Kampala cost of the product -- and high wholesale and retail costs because of the small size of the market. Another reason is the high taxes levied on petroleum: tax rates of the respective CIF prices range from 175% for petrol, 130% for diesel and 90% for kerosene.[6] As a result, almost half of the retail price for petrol and diesel are taxes. Yet an additional reason for the high prices has been the oil companies' relatively high margins before the liberalization. Given the significant price differential between Kenya and Uganda, smuggling has developed quickly, particularly in the eastern regions of the country. It is estimated that about 10 percent of the petrol, kerosene and diesel consumed in Uganda was illegally imported in 1993. It is, thus, estimated that the

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5 Recommended Changes in Government Policy in the Petroleum Sector of Uganda, December, 1993 by P. A. Dubrule.

6 Duty is charged on an ad valorem cost basis, CIF Uganda terminal, on the volumes leaving the oil companies' terminals anywhere in the country. Resident Customs officers are located at all oil company terminals. The oil companies are required to maintain a substantial positive balance with the URA to insure that the trucks leaving the terminals will be passed by the Customs officer.

Government lost about 10 billion shillings in revenue from petroleum taxes. Table 2.2 below provides the cost structure for petrol, diesel and kerosene.

Table 2.2 Petroleum Product Cost Structure (as % of retail pump price)

	Petrol	Diesel	Kerosene
FOB Gulf	17%	19%	22%
Shipping to Mombasa	3%	4%	4%
Inland Transport etc.	10%	11%	13%
Uganda Wholesale	17%	21%	23%
Uganda Retail	4%	4%	5%
Uganda Taxes	49%	42%	33%
Retail pump Price	100%	100%	100%

Source: Ministry of Natural Resources, 1993.

2.11 The Government deregulated the retail price of petrol, kerosene and diesel in January 16, 1994. This, coupled with the liberalization of the foreign exchange market has opened the door to competition.[7] Oil companies are currently re-negotiating their rail and truck transportation contracts and efficiency studies are underway. (More retail outlets will probably close.) They are also investing in storage terminals to improve safety and pollution control. The marketing companies are making repairs and beautifying the service stations.

2.12 However, during the two years of liberalization, the competetive pressures on pump prices have been weak. In the first few months, retail prices fell slightly in Kampala and other urban districts and remained unchanged in the rest of the country. No major changes in price have been reported between Kampala and the rest of the country during the following months, which means that oil companies are allowing some cross-subsidization. Pump prices started to increase over the summer 1994, and the MNR expressed concern that the oil companies were not passing all the benefits of liberalization to the consumers. The rise in prices could, however, be partly explained by the increase in international petroleum prices, although the appreciation of the Uganda shilling over the dollar (more than 10% between March and June 1994) should have offset it. On the other hand, pump prices declined slightly in February 1995, despite an increase in world crude oil prices. Table 2.3 compares product prices before and after the liberalization.

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[7] The foreign exchange controls were eliminated in November 1993. Dollar accounts may be maintained. Dividends may be remitted. Letters of Credit are no longer required by offshore suppliers. Payments are made by bank draft or telegraphically. As a consequence, the oil companies are no longer incurring foreign exchange losses from their sales in Shillings, as was previously caused by delays in being granted foreign exchange for imports. This will encourage imports to be made in larger cargoes, and less frequently. Also, there will be a savings of 3% of the CIF Kampala cost (0.7 US cents/litre) for a Letter of Credit/Import License that was allowed in the old pricing formula. In addition, the oil companies will save the cost of tying up working capital for a cargo import for at least 50 days, which is worth 0.1 US cents/litre. This can be calculated as follows: Assume US$ 165/M3 CIF x M3/1000 litres x 4.3125% (current LIBOR Interest) x 50 days/365 days = 0.1 US cents/litre.

Table 2.3 Petroleum Product Pump Prices in Kampala (Ush/litre)

	October 1993	December 1993	March 1994	June 1994	September 1994	February 1995
Petrol		890	870	910	920	910
Diesel	830	820	800	830	795	790
Kerosene	710	710	690	750	700	670
Crude Oil (Dubai, $/bl)	14.7	12	12.2	16.7	15.5	16.6
Pr. Gasoline (CIF Europe $/tonne)	165	150	175	190	175	170
Exchange Rate USh=1$	1170	1146	1080	963	921	935

Source: MNR, Ministry of Finance, Bank of Uganda, Petroleum Economist.

B. Cost-Effective Supply Strategy and Investment Requirements

2.13 In a liberalized and competitive petroleum market, such as Uganda's, the oil companies are expected to minimize their costs by selecting the most cost-effective supply modes. However, in the interest of consumers, the Government should ensure that the cost-effectiveness criteria is not compromised because of failures in the market. The Government should compare the costs of different supply modes and encourage the oil companies to adopt the most beneficial strategy and to make the required investments. This strategy should be balanced with an assurance of security of supply. The evaluation of the costs of different supply alternatives is also useful for price monitoring purposes. The issues to be addressed in determining the least-cost supply strategy concern: (a) the most cost-effective supply alternative; (b) the most efficient ratio between Kenya-sourced and Tanzania-sourced products; and (c) the least-cost investment requirements (public and private) in the short and long term, to ensure that sufficient capacity is available in the supply chains to meet the forecast demand.

2.14 **Supply Alternatives**. The Energy Assessment Mission carried out a preliminary examination of three alternative cases of two-route supply to determine the least-cost supply mode to meet the forecast demand. These were:

Alternative 1: continuation of the existing arrangements through Kenya and Tanzania and the purchase of new trucks and tank wagons to transport increased quantities.

Alternative 2: for Kenya source: a new pipeline from Eldoret to Port Bell (or Jinja) and for Tanzania source: continuation of the existing arrangement, i.e. rail and rail-ferry.

Alternative 3: for Kenya source: pipeline to Kisumu and self-propelled barges to Port Bell and for Tanzania source: continuation of existing arrangements.

2.15 The analysis indicated that Alternative 3 is the least-cost supply mode. It effectively provides three supply routes, (because minor quantities could be supplied from Eldoret by rail), and maintains use of URC's existing investments, (i.e., the trucking fleet can be utilized effectively as some trucks can shift from transporting white products

to transporting fuel oil).[8] Furthermore, the deployment of barges should add flexibility, as purchases will be possible anywhere on Lake Victoria. This alternative is also the least investment intensive of those studied, and reduces the risk of disruptions by diversifying supplies and providing leverage in negotiating inland transportation tariffs. URC should pursue petroleum product transportation by rail at all times even in the face of strong competition. The recent URC policy to take responsibility for product losses in excess of 0.5 percent should attract new business. In addition, by maximizing the use of the rail-ferry on Lake Victoria, URC would take the maximum advantage of the investments already made (Annex 2.11).

2.16 **Import Ratio**. The construction of the new KPC pipeline from Eldoret to Kisumu, directly on Lake Victoria and the lowering of the pipeline charge (US$40/ton), makes this route the most viable one for sourcing products from Kenya, and could be more economic than the Tanzania route. However, even if the Tanzania route was slightly more expensive, it should be maintained to handle a substantial (25-30%) share of the Ugandan market for supply security.

2.17 **Investment Requirements**. Additional products tankage will have to be built in Uganda to meet increased demand. In accordance with the Supply Alternative 3, new tankage should be built at Port Bell. It lies only nine kilometers from downtown Kampala and is already the principal terminal for supplies from Kenya and Tanzania. The Port Bell option, however, should be compared to rehabilitating and converting the Jinja facility for commercial purposes. The "sunk-cost" in this facility could compensate for the higher transportation costs to Kampala. In both cases, the investments would be made by the private sector. The long-term goal is further to eliminate the oil company terminals in the heart of Kampala. Outside of Kampala, the need for additional tankage will depend on the oil companies' supply and distribution logistics, but is also influenced by the demand growth rates and any minimum stock requirements the Government considers necessary.

2.18 The long-term investment profile of the facilities required for Alternative 3 above would include: barges with a capacity to transport about 250,000 to 300,000 tons per year, either from Kisumu or Mwanza; and the rehabilitation of the existing storage facilities and building of new storage, tankage, terminals and loading/unloading racks. All these investments would be provided by the private sector.

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[8] Moreover, the general use of barges on Lake Victoria increases the possibilities of sourcing product from Mwanza and delivering it at either Port Bell or Jinja. A jetty at Kisumu, (with an estimated cost of US$ 3.5 million), a component of a Bank project under negotiation with Kenya, could serve all markets around the Lake, including Mwanza on the Tanzania side.

C. COMPETITION IN SUPPLY

Price Monitoring

2.19 The elimination of foreign exchange and petroleum price controls should spur competition between the six oil companies and result in the lowest possible price. Two years after the liberalization, the market has become more competitive, but there are also signs that prices have not always adjusted to changes in world oil prices, thereby not providing the correct signals to consumers. Therefore, the possibility of collusion between the oil companies, both in procuring product offshore and supplying it to the Uganda market, or other market failures that may distort prices should not be overlooked. The Government should ensure that the oil companies' behavior promotes competition so that the benefits of deregulation are passed on to the consumers.

2.20 The Petroleum Division of the MNR has been given the dual responsibility of monitoring supply costs and the corresponding pump prices to determine if the desired forces of competition are at work. However, the MNR has neither enough institutional capacity nor adequate information to effectively carry out such monitoring at present. On MNR's request, IDA has agreed to provide technical assistance to design and implement a price and quality monitoring system, under the energy component of the Third Power Project (Cr.2268-UG.). MNR should proceed expeditiously in procuring the required technical expertise to design the monitoring system and a mechanism for cost recovery, as well as an adequate legal framework for implementation and enforcement. The MNR should also proceed with the required training and institutional arrangements for the establishment of a permanent monitoring body.

2.21 The price monitoring system should monitor prices at the port, the border and the pump. To implement such a system it is necessary to: (a) establish an accurate price build-up for CIF Kampala price comparisons to check offshore price differences; and (b) initiate an on-going pump price monitoring system to check whether competition or collusion is at work.

2.22 **CIF Kampala Price Monitoring.** The CIF Kampala cost for each product can be calculated using publicly available information, such as quotations for FOB prices, ocean freight, and insurance costs. Other required information include: the handling, transit and product loss charges; and working capital costs. This will provide a reference cost which can then be compared to the actual costs incurred by the oil companies. The MNR should make funds available to purchase the sources where the various cost quotations can be obtained; Platt's weekly summaries, for instance. Since portions of the CIF Kampala cost to the oil companies are covered by various invoices (i.e., inland transportation billed and paid separately), the MNR would need to obtain the actual data regularly from each of the oil companies who must be assured that the information will be held confidentially (Annex 2.6).

2.23 **Pump Price Monitoring**. In order to monitor prices at the retail level, the MNR should monitor prices at the service station. Oil companies have pump price data for their various service station locations which may be obtained by the MNR on a weekly basis.

2.24 In the event that the monitoring indicates the oil companies are being over-charged by their suppliers (compared to FOB prices); or by their providers of ocean freight (compared to the ocean freight cost calculations, while considering their two port discharge operations); or in the event that there are signs of collusion or price fixing, the Government should establish methods to sanction anti-competitive behavior. Such methods include the resorting to centrally administered ICB or regulated prices (Annex 2.7). Adequate enforcement mechanisms should be examined as part of the system design process.

Product Quality Monitoring

2.25 In addition to price monitoring, the Government should oversee that the quality of products sold in the country conform to established standards. It is recommended that the quality monitoring be initiated expeditiously by the Bureau of Standards, since it appears to be in the best position of reaching all service stations.[9] A complete set of petroleum product specifications should also be compiled. More complicated tests, such as the sulfur content of petrol, kerosene, diesel and fuel oil, and the octane number rating of petrol, could be handled by the laboratory of the Mombasa or Dar es Salaam refineries. The cost of the tests and enforcement monitoring should be passed on to the oil companies.

D. SAFETY AND ENVIRONMENTAL MANAGEMENT

2.26 Without appropriate practices for the handling and use of petroleum products, several environmental problems may arise, including: (a) possible health hazard from improper disposal of toxic petroleum product wastes; (b) air pollution; and (c) environmental damage from oil-spills. In addition, adequate fire protection is essential in oil operations.

2.27 Petroleum products wastes are generally handled in accordance with good operating practices in Uganda. A number of market and non-market incentives exist that encourage efficient environmental management. The major policy goal should, therefore, be to ensure that appropriate preventive measures are followed. Annex 2.8 discusses waste management policies in greater detail. With regards to air pollution, the main source in Uganda is vehicle emissions. Though the situation is not of grave concern or high priority at present, Annex 2.9 discusses possible longer-term goals. Potential environmental damage from oil-spills and fire explosions indicate two main areas for

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[9] The system would require the testing of API gravity, flash point and Reid vapor pressure for petrol; and the purchase of a few inexpensive pieces of testing equipment.

concern: (a) oil-spill response, fire protection and standards of safety maintenance at product storage facilities; and (b) oil-spill response on Lake Victoria. These two issues are discussed below.

Oil-Spill Response, Fire Protection and Safety Maintenance at Storage Facilities

2.28 These issues concern mostly the Jinja strategic storage facility, since the oil companies generally appear to meet oil industry standards, and many are in the process of investing in various oil-spill prevention, evaporation-reduction or fire-protection projects for their terminals. By contrast, the present operation of the Jinja facilities is hazardous. Its fire protection capacity is minimal and because it also lacks oil-spill response and handling equipment, any spillage in loading or unloading, tank failure, earthquake, lightning, faulty truck or simple accident could cause a major problem. Not only are the plant personnel at risk, but the tanks, their contents (current replacement cost of the products is US $4.4 million), and possibly the surrounding area.

2.29 To mitigate the risk of major environmental or safety emergency, a complete rehabilitation with emphasis on installing adequate fire protection and oil-spill response facilities should be carried out. These works could take up to 18 months and cost around US $0.4 million. During the rehabilitation, all the storage tanks must be emptied to minimize safety risks by selling off the **entire inventory** of products at Jinja, a move which would also provide funds for the required works. This should not pose any supply security risks, since the two supply routes operate well at present. However, since the Government considers strategic stocks to be important for the security of a land-locked country, it could ask the oil companies to increase inventories during this period when strategic stocks are drawn down. Alternatively, the Government could ask the oil companies to re-open their closed terminals in Mbale and elsewhere, if necessary.

Oil-Spill Response on Lake Victoria

2.30 The ferries and dock area have neither equipment nor established procedures to follow in case of an oil-spill.[10] At dockside, also fire protection is inadequate. To reduce the hazards of a potential oil spill, URC should install oil-spill response equipment and develop an oil-spill response emergency plan and train personnel in its implementation at Mwanza and Port Bell, and also at Kisumu, given the possible use of self-propelled barges.[11]

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[10] URC was scheduled to get two sets of fire-fighting equipment by April 1995, and the oil-spill containment equipment by September 1995.

[11] It is understood that URC has ordered an oil-spill containment boom; however, this by itself is not sufficient. A work-boat launch is necessary to deploy the boom and to be equipped with oil skimming facilities. A Transvac Vacuum unit and small boats with spray equipment should also be procured. Approved dispersants and adsorbent materials should also be on hand (Annex 2.10).

E. Management of Strategic Stocks and Government Ownership in Oil Companies

Management of Strategic Stocks

2.31 In addition to addressing the environmental and maintenance problems of the Jinja facility, the issue of the most efficient means of managing operational stocks should be examined. An efficient operation of any storage facility requires, for instance, that the stored products are completely turned over every six months to ensure adequate product quality. The turn-over at Jinja involves only one-half of the stored volume, mainly because the market in the Jinja area is too small to facilitate an adequate turn-over. (It would take one year to turn over the diesel tank, and 3.5 years for the kerosene tank). The products would, therefore, have to be transported to Kampala, which is about 80 km from Jinja. This would incur excessive transportation costs to the oil companies and effectively discourage them from procuring from Jinja. Additionally, because of the haphazard turn-over, Jinja's current product losses are very high, worth about US $100,000 per year or about 10 times the economic level. Over and above these operational efficiency issues, a well-run facility should have adequate product testing facilities and well-trained staff with expertise in oil operations.

2.32 This raises the issue whether a change in the management of the strategic stocks would be beneficial. Two alternatives emerge as worthy of further consideration: (a) management of Jinja by the oil companies; and (b) incorporating strategic stocks into oil company storage.

2.33 **Oil Company Management Of Jinja.** Government ownership and operation is often justified on the grounds that the Government needs to control the country's emergency stock. However, inevitably, during a supply emergency, the Government would have to co-operate with the oil companies to mitigate the problem and to administer any emergency allocation plan. The main argument against Government operation is that it requires the Government to build up its own capacity in an area where the private sector already has adequate expertise. This includes staff who are well-trained in oil terminal operations, acceptable standards of safety maintenance, fire protection and oil-spill response; as well as knowledge and experience of the oil business, ranging from oil accounting, to loading-rack operations, to checking product quality. The oil companies already have the required expertise available in Uganda and can obtain additional technical support from their parent companies when needed.

2.34 If the management of strategic stock is provided by the oil companies, the facilities can be owned either by the Government or by the oil companies. Under the current supply arrangements, the Jinja facilities may be too poorly located for any oil company to desire ownership. However, given the significant "sunk cost" in the Jinja facility, it could also be considered an alternative to building new storage in other locations to meet future requirements. However, since this option requires the rehabilitation of the facility and incurs increased transportation costs, the Government

should determine whether using Jinja as a commercial storage is part of the least-cost option for storage capacity expansion. Should this not be the case, the Government should investigate the cost-effectiveness of treating the Jinja facilities as strategic storage in a leasing arrangement with a consortium of the oil companies..

2.35 **Incorporating Strategic Stocks into Oil Company Storage**. In some countries, separate strategic storage facilities have been abandoned in favor of using the oil company terminals to provide storage for strategic stock. The oil companies carry a certain amount of stock above their operational requirements. For this service, they are reimbursed for the required additional working capital as well as for a portion of product loss and operating costs. As additional facilities are required, the companies build them and are allowed a fair return on their capital investment. In other countries, where the government has mandated minimum stock requirements for each product, joint storage facilities are common. In such cases, the capital could be provided by the oil companies in proportion to their market share, and the terminal could be operated by the companies on a rotating basis. The oil companies recover all operating costs plus a fair return on any investment.

2.36 The Government should carefully examine the feasibility and cost-effectiveness of incorporating strategic stocks into existing oil company storage. However, if it decides to maintain the Jinja facility as a storage facility for strategic stock, the most efficient mode of operation appears to be to lease the facility to the oil companies. To this end, the Government should request proposals from the oil companies to operate, rehabilitate and maintain Jinja on a strategic storage model basis. The lease contract would determine each party's responsibilities and how the oil companies are compensated. Since strategic storage is provided mostly for the benefit of the consumer, the consumer should bear all the costs.

Government Ownership in Oil Companies

2.37 At present, the Government owns 50 percent of Agip and Total. These two companies together have a market share of 31 percent, giving the Government a control of 15 percent of the market. Because many of the large consumer accounts in Uganda are parastatals and these sales are usually based on bid tenders from the oil companies, there is a perceived conflict of interest by having a Government interest in the oil industry. There appears to be little or no reason for Government investment in these oil companies and the Government should consider divesting its holdings.

F. ILLEGAL IMPORTS

2.38 During the past couple of years, the Anti-Smuggling Unit of the URA (Uganda Revenue Authority) has made considerable strides in curtailing petroleum smuggling at the eastern border: it has impounded trucks, arrested people and audited service stations. Trucks transporting petroleum products to Kampala are now required to form a convoy of 8-10 trucks at the border before being allowed to continue. After an

appropriate time period, Customs checks the oil companies' terminals to verify the arrival of the trucks. Trucks that are in transit through Uganda to Rwanda and eastern Zaire are, however, a problem, since the Customs have limited possibilities to control them. Given the large price differentials between Kenya and Uganda, a certain amount of smuggling is to be expected. In order to further discourage smuggling, however, it would be worthwhile to investigate whether harmonization of prices in border areas with adjacent countries could reduce illegal imports without reducing fiscal revenues.

G. Ethanol Blending Program

2.39 With a view to reducing the high petroleum products import bill, the Government has seriously considered producing ethanol at the main sugar estates. A study envisioning the construction of two ethanol plants, one at Lugazi Sugar Estates and one at Kikira Sugar Estates, was completed in November 1992, and concluded that the projects were not viable.[12] The oil companies have also raised doubts on the viability of the program and indicated that they would participate only if the Government guarantees full cost recovery. The Government should not offer any incentives for potential ethanol producers and should not guarantee a market. Instead, the Government should steer clear of this project and pursue other measures for reducing fuel consumption, for instance by encouraging end-use efficiency, including better maintenance of vehicles.

H. Petroleum Exploration

2.40 No oil discoveries have been made, though three main sedimentary basins have been identified in the west of Uganda, and several others in other regions. The western basins have sediments of around 4,000 meters in depth and are potential prospects for petroleum discoveries. However, only aeromagnetic, gravity and surface geological surveys have been conducted and no seismic survey or exploratory drilling has been pursued. Product sharing legislation is in place and the MNR has prepared a promotional package to attract companies to explore in Uganda. Several companies have expressed interest but none has made concrete proposals. A perceived problem has been whether any discovery would be marketable. A large discovery, adequate to underpin either a refinery or a pipeline would be very attractive to the private sector because of the high prices of petroleum products in Uganda. However, smaller discoveries might have to be moved to refineries abroad by tankers, thus incurring prohibitive transportation

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[12] The economic analysis included in the study indicated that the projects were not viable at that time for several reasons, namely: (a) the plants were to be owned by the sugar estates and, hence, partly owned by the Government, which may have caused some financing difficulties; (b) the anticipated loan financing had an exposure fee of US$ 300,000; (c) Government import duties of 25% were assumed to apply to all imported plant equipment; (d) the CIF landed Kampala cost for petrol was USh 277 per litre (23.1 US cents/litre) which was required as the ethanol selling price. Since then, the foreign exchange market has been liberalized and the CIF landed Kampala cost of petrol is USh 255 per litre (22.2 US cents/litre).

costs. Although the potential for petroleum discovery is present in the Ugandan portion of the African Rift system, there is also a high risk of failure; this is truly a frontier basin.

2.41 Uganda has already build up a considerable capacity in oil exploration promotion and further institution building efforts could be deferred until an oil discovery is made. The Government should focus its efforts on promoting Uganda's oil potential to the small independent oil companies, because the major players may be only moderately interested in Uganda at this time, given the low world oil prices and more promising prospects in other parts of the world.

3. POWER SUB-SECTOR

3.1 Much has been done to bring the power sector back from the depths to which it had fallen during Uganda's years of civil strife. With the support of IDA and a number of other multilateral and bilateral donors, who have provided generous financial support and a wide array of technical assistance, the government has invested heavily in rehabilitating the sector's infrastructure and rebuilding its institutions. On the physical side, the results have been broadly satisfactory. While progress has been much slower than hoped, the work of rehabilitating the country's priority generation, transmission and distribution facilities is now well advanced. Unfortunately, the results on the institutional side have been far less satisfactory. Although improvements have been made, UEB remains inefficient, provides poor quality service and is still in a precarious financial condition, unable to earn a profit, service its debts or contribute significantly to meeting its investment needs. Therefore, the sector lacks the institutional strength to play its role in the economic and social development of the country: to meet the energy needs of a growing economy and provide more of the population with the benefits of electricity.

3.2 The principal issues facing the sector are, thus:

- **Institutional Change** -- Establishing institutions that operate efficiently, provide high quality service and are financially sound.
- **Private Sector Participation** -- Making greater use of the resources of the private sector to help address sector issues.
- **System Development** -- Choosing a least cost-path for expanding system capacity to meet the needs of a growing economy and take advantage of export markets.
- **Extending Electrification** -- Widening access to electricity by extending the grid and/or opening the way for non grid-connected conventional and non-conventional sources of supply.

The principal options for dealing with these issues are examined below, following a brief review of the current situation in the sector.

A. THE POWER SYSTEM

Electricity Supply

3.3 **Utility Facilities.** For all practical purposes Uganda and UEB depend on a single hydro power source, the Owen Falls plant which opened in 1954 and originally had an installed capacity of 150 MW (10x15 MW). The dam, powerhouse and generators

have been undergoing intensive rehabilitation since 1986. This work, which was originally scheduled to be completed by 1990, is now expected to take until 1997. When completed, it will raise the capacity of the plant to 180 MW; it will be capable of generating some 1000-1,100 GWh/year under present operating arrangements. UEB operates also a mini-hydro plant at Kabale, and eight small diesel generating plants in isolated systems (units of less than 200 kW each). The transmission facilities include 887 km of high voltage lines, mostly at 132 kV. There are 6,110 km of primary distribution lines at 33 and 11 kV, 540 MVA of power transformers and an undetermined amount of distribution transformers. The transmission and distribution systems have also benefited from intensive rehabilitation works under which many lines have been replaced and new transformers installed, during recent years. The general system map in Annex 3.1 shows the locations, and a list of facilities is reproduced in Annex 3.2.

3.4 A second power plant, the Owen Falls Extension, is also now under construction. The Extension's installed capacity will be 80 MW (2x40 MW) initially, with provision for adding another 120 MW. The anticipated energy production will be between 500 and 600 GWh/year, raising system generating capability to some 1,500-1,600 GWh/year. The Extension was intended to be in commercial operation in 1995, but is now scheduled for commissioning in 1998.

3.5 **Utility Operations.** The system operates inefficiently and provides poor quality service to consumers. Losses are very high, with some 215-250 GWh/year, or about 25 percent of total generation, having gone unaccounted for over the past three years (1992-94). Excluding exports, losses appear even higher, amounting to about 30 percent of energy sent out to Uganda over the same period. While these are all losses to UEB, they are not all losses to the economy. UEB's billings are notoriously inaccurate and it is estimated that as much as one-third of amounts reported lost are non-technical losses reflecting consumption by unregistered or illegally connected consumers. Nevertheless, at an estimated 20 percent or so, the apparent technical losses to the system denote an extremely inefficient operation.

3.6 Power outages are frequent, as are brownouts (periods with unsatisfactory voltage levels, generally below 90 percent of nominal value) and wide voltage fluctuations. Customer service by the utility is slow or non-existent. The outages are caused both by system breakdowns and deliberate load-shedding by UEB. In either case, they impose severe costs on the economy and on the system's customers, as also do the frequent voltage fluctuations that shorten the life of light bulbs, and damage motors and appliances. Since no data on service quality is systematically collected, evidence of the extent and trend of the problem is almost entirely anecdotal. Most recently, such evidence indicates some improvement in the situation, as might be expected in view of the progress made in system rehabilitation. Industrial and commercial consumers indicated they were experiencing fewer difficulties when informally surveyed in mid-1994 and UEB reported at the same time that load shedding due to distribution deficiencies and faults at Owen Falls were down sharply.

3.7 **Non-Utility Facilities.** Many industrial and commercial enterprises have their own emergency generators but the number of plants owned and operated by industry and by private users is not known with precision. The largest privately-owned facility is a 5 MW hydro plant at Kilembe, built to serve a copper mine which is shut down at present. At present the plant serves only the community, and acts as backup in emergencies for UEB facilities. A few thousand photovoltaic installations are believed to be in use in rural areas, where they mainly supply lighting to residences and small organizations. There is no evidence as to whether, or to what extent, small gasoline generators or car batteries are used for such purposes, as they are in many parts of the world.

Consumption of Electricity

3.8 **Consumption.** Only a small part of the population of Uganda is supplied with electricity and national consumption is very low. Service is currently available to only about 5 percent of the population of 18 million. The great majority of the people are either not within reach of the electricity system, or cannot afford the service. On a per capita basis, the national average electricity consumption is a very low 44 kWh per year. The average is made up of a relatively high energy consumption in the Kampala-Entebbe district (approximately 170 kWh per inhabitant) and consumption of less that 10 kWh/year per inhabitant in most outlying districts. Of the officially reported 110,000 electricity users, more than half are in the capital, Kampala, and most of the remainder are in the major towns (according to a recent UEB survey, the real number of consumers may be as low as 67,000).

3.9 Most of the electricity is consumed by residential or service sector users. Productive uses account for a small proportion of the total. The main categories of users are residential (55% of total energy billed in 1995), commerial/general (24%), industrial (20%), and street lighting (1%). The bulk of the electricity (72%) is consumed by the 12 percent of the population that lives in the Kampala metropolitan area, and in the nearby cities of Entebbe and Jinja. The towns in the outlying districts have a much lower density of energy consumption. In sum, electricity serves mainly the capital region, and a few of the other major towns.

3.10 UEB's sales records point to the not unexpected picture of sharply increasing loads during the period of recovery from civil strife beginning in the mid 80s, followed by much slower growth in recent years (Table 3.1). UEB's reported sales in Uganda increased by about 8 percent annually during 1986-90, rose sharply again to about 500 GWh in 1991 but have stagnated since then. However, UEB's sales are an uncertain guide to actual consumption trends, depending as they do on the vagaries of its billing practices. A better picture may perhaps be derived from looking at the difference between total electricity production and exports (presumably the two most reliable statistics reported by UEB) which indicates the amount of electricity (including purported losses) supplied to the Ugandan market. "Total supply" rose more rapidly than reported sales in the earlier years and has continued to increase in recent years, albeit at a

slower pace. This picture seems to better accord with other indicators, such as the number of connections, which has continued to increase in recent years.

3.11 The rapid load growth in the recovery years was led by residential consumers. However, reported sales to residential consumers peaked in 1991 and appear to have dropped off since then. Sales to commercial consumers have also been flat in recent years. The recent weakness of sales in these categories has been offset by growth in sales to industry and in the catch-all "general" category of consumers, and may, thus, indicate problems in customer categorization.

Table 3.1: Electricity Supply and Demand, 1986-95 (GWh)

	1986	1990	1991	1992	1993	1994	1995 Preliminary
1. Production	637	738	785	994	978	1017	1057
2. Exports	231	166	150	289	259	252	195
3. Total Supply to Uganda (1-2)	406	572	635	705	719	765	862
4. Sales	299	408	504	485	473	489	488
Residential	139	274	328	263	272	286	267
Commercial/ general	108	84	100	142	127	116	120
Industrial	41	45	65	73	71	82	98
Other	11	5	11	18	3	5	2
5. Losses (3-4)	107	164	131	215	246	276	374

Note: Losses appear to have increased significantly in 1995. However, this may be due to the preliminary nature of the 1995 data and deficiencies in the billing records.

3.12 **Resources.** Uganda is well endowed with resources for power generation. Most important are the hydro power resources of the White Nile along which six major sites, with an estimated total capacity of 1,800 MW, have been identified between Owen Falls and the border with Sudan (see Annex 3.3 for details). In addition, there are an unidentified number of mini-hydro sites on the tributaries of the Nile, and a number of geothermal occurrences south of Lake Edward, which might be developed on a small scale to supply power in areas remote from the UEB grid. Uganda also has excellent solar and other renewable energy resources (see Chapter 4).

Institutional Framework

3.13 **Structure.** The power sector is regulated by the Electricity Act of 1964, which makes the Government (the Ministry of Natural Resources) responsible for policy formulation and operational oversight while leaving UEB a fair degree of autonomy in the conduct of day to day operations. The Act gives UEB a monopoly in generation, transmission, and distribution of electricity in Uganda. It also allows UEB to sell power

abroad. In practice, UEB not only operates both at the retail and wholesale levels in Uganda and exports power in bulk to the neighboring countries but also engages in a wide range of ancillary activities, such as manufacturing electrical products and building staff housing. While the Act does not give UEB an explicit regulatory function, it does require anyone who wishes to produce or sell electricity outside their own premises to obtain a license from UEB.

3.14 **Performance.** In addition to the operating difficulties already noted, UEB has also been a very weak financial performer. UEB's financial statements indicate that during the last five years, 1990 to 1994, two years ended with net operating losses, and three years showed a nominal profit. However, as the auditors' qualifications note, the financial statements do not include sufficient allowances for bad debts and for doubtful accounts receivable. If suitable allowances were made, it is estimated that the 1994 accounts might show a substantial loss and a negative rate of return. Be this as it may, UEB's financial situation at present is clearly such that it cannot earn an adequate rate of return, service its debts, and contribute significantly to the financing of needed investments. It is, thus, not a financially viable entity at present.

3.15 UEB's problem has not been low tariffs. As the result of sharp increases in 1992 and 1993, and the rising value of the shilling, UEB's average tariff now stands at the equivalent of about USh 98 per kWh, which is in line with the Long-Run marginal Costs of Supply (LRMC).[13] Rather, UEB's financial difficulties stem mainly from high system losses, inaccurate billing and poor collections. In recent years, UEB has been sending out bills for only about two-thirds of the electricity it has supplied to the domestic market and collecting payment for only about half of the amounts billed -- i.e., it has been receiving revenue for only about one-third of the power supplied to Uganda. With billings so far exceeding collections, accounts receivable have been far above the 3 months' level agreed with IDA (UEB's tariff schedule is reproduced in Annex 3.4).

3.16 High staff costs have also contributed importantly to UEB's financial difficulties. From 1989 to 1993 the number of employees increased by 40 percent to 3374 while the number of customers increased by 17 percent from 94,000 to 110,000. The ratio of customers served per employee has deteriorated from 39 to 33. This ratio is a commonly used indicator, which, for a reasonably efficient utility, should be in the 100-200 range. Salaries and wages have continued to increase both in terms of remuneration per employee, and as a proportion of the total operating expenditures of UEB. While in 1989 salaries and wages made up 22 percent of total operating expenditures excluding depreciation, by 1994 they had risen to 43 percent (Annex 3.5).

B. Institutional Change

3.17 While much of today's difficulties can be traced to Uganda's years of civil strife and disruption, the fact that sector performance remains so weak after many years

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[13] Estimated in 1990 at $0.07/kWh. SAR, Third Power Project, para 1.17.

of physical recovery and much technical support makes a clear case for significant institutional change. The need for change seems most pressing in three areas: (a) sector organization, particularly concerning the relations between the government and operating entities; and (b) the execution of the distribution and commercial functions, which lie at the heart of UEB's operational and financial difficulties.

Sector Organization

3.18 Experience indicates that the power sub-sector functions best where the operating entities are autonomously managed, commercially oriented and accountable for their performance. This is not the case in Uganda. Although under the Electricity Act UEB is autonomous in principle, the Minister not only has the authority to give UEB directions on matters of policy but also must approve changes in tariffs or other major measures. He also appoints its Board of Directors, which consists entirely of public officials who serve at the Minister's decision, and which appoints UEB's chief executive, the Managing Director. As regards commercial orientation, no organization which "loses" one-quarter of the value of its total production and fails to collect payment for another quarter, can be mistaken for a commercial enterprise. Finally, as concerns accountability, the Ministry lacks the resources necessary for effective oversight over what is Uganda's largest bureaucracy which, like most such organizations, often moves in its own ways.

3.19 The establishment of a new relationship between the Ministry and UEB, based on arm's-length regulation of the utility's operations and finances in accordance with well structured criteria, could do much to inject a more meaningful measure of autonomy, commercial orientation and accountability into the sector. Having established "rules of the game" would benefit both institutions, giving UEB greater operational autonomy while enabling the Ministry to not only exercise effective oversight but also to devote a greater share of its attention and resources to its primary policy function.

3.20 While arm's-length regulation length can often best be achieved through the establishment of an independent regulatory agency, given the scarcity of technical and managerial resources in Uganda it may be more practical, at least initially, to think of locating the regulatory function in an administratively distinct office of the Ministry. Whatever the location, the principal objectives of regulation would be to ensure that:

- the supply of electricity is adequate to meet the needs of a growing economy,
- electricity is generated, transmitted and distributed as efficiently as possible,
- high levels of reliability are maintained,
- access to electricity is expanded to the extent economically feasible,

- revenue is sufficient to cover economic cost, and
- entry to the sector is open to all who can contribute to the achievement of the above objectives.

3.21 **Regulating Operations.** Operations can be regulated by influencing either the conduct or the performance of the operating enterprises. Conduct regulation relies on direct control of enterprise behavior through, e.g., the detailed vetting of operating budgets and investment plans. It has been the approach traditionally employed in most developing countries where, as in Uganda, power operations have been reserved to the public sector. It has rarely been successful because it blurs the distinction between regulation and management, deprives enterprise managers of real responsibility and opens the door to political interference.

3.22 For these reasons, there has been increasing interest in performance based regulation, which aims to secure desired outcomes by setting targets and providing incentives. The twin keys to successful performance regulation are the establishment of credible targets and the maintenance of accountability for the achievement of these targets. To be credible, the targets must be set in terms of performance indicators that are objective and measurable and, like all good targets, must reflect a judicious balance between what is desirable and what is achievable in a given time frame. Targets should be selected and framed to cover the areas of performance most in need of improvement. They may include some or all of the following:

- Supply: kWh generated; peak demand met
- Efficiency: fuel consumption; reduction of line losses; staff per kWh sold
- Reliability: reduction in number/duration of outages and brownouts; voltage maintenance
- Access: number of new connections
- Investment: physical implementation of projects; adherence to project budgets
- Finances: rate of return; self-financing of investment; reduction of receivables

3.23 Performance based regulation is most likely to be effective where targets are established by mutual agreement between the regulator and the operating enterprise; where the enterprise is given both the resources and the incentives to meet the agreed targets; and where there is a suitable mechanism for ensuring accountability. The targets, resources and incentives should be defined in contracts. These contracts include: (a) performance contracts that define the relationship between the Government and

government employees managing a utility (box 1); and (b) management contracts that define the relationship between the Government and a private firm contracted to manage a utility (box 2). Such contracts contain not only performance targets but explicit reciprocal obligations on the part of the regulator (government) to, for example, allow tariff increases, and obtain foreign loans if the enterprise performs as agreed. Because the targets are mutually agreed upon, they are more likely to be realistic and to reflect a real commitment on the part of the enterprise than targets handed down unilaterally by the regulator. And because they contain verifiable, numerical targets, performance and management contracts provide a means of ensuring that enterprise managers know exactly what they will be held accountable for and how it will be measured.

3.24 While both performance and management contracts aim to improving efficiency, the experience of these two types of contracts has not been alike. A recent World Bank study found that management contracts, though not as widely used, have been more successful than performance contracts.[14] The main weaknesses of the performance contracts studied were that they: (a) did not reduce the manager's information advantage: instead, managers were able to use their knowledge of the firm to negotiate soft targets that were easy to reach; and (b) did not include rewards and penalties that could motivate managers and staff to exert more effort. In addition, government regulators often lacked the power to enforce the contract terms reliably. The most successful management contracts, on the other hand, involved competitive bidding for the contract to reduce management's information advantage; established meaningful rewards and penalties, usually linking the contractor's fee to the firm's performance; and elicited a strong commitment from both parties. For example, they covered longer periods, included the possibility of renewal, and provided for arbitration of disputes. Overall, the World Bank study concluded, that, the greater the participation of private agents in ownership and management, the better the enterprise performance.

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[14] Bureaucrats in Business, a World Bank policy research report; World Bank 1995.

Box 1: Examples of Performance Contracts

France: The first *contrat-plan* was signed with Electricité de France (EdF) in 1970 and is considered the contract plan model. It reduced government control by allowing greater regulation by market forces. This was in response to EdF's entering the competitive industrial-heating market, adopting a profit-center approach and decentralizing financial management. After 1987, EdF expanded its scope for competition by exporting its surplus capacity to other European utilities. Its contract plan therefore focused more on increasing efficiency and reducing costs. Five-year contract plans regulate the company by comparing actual performance against key objectives such as productivity targets, rate commitments, sales and investment strategies, self financing and debt strategies, and wage and salary scales. Objectives are set by each department's corporate plan, and efficiency is encouraged by comparing performance of similar units. Rates are based on the marginal cost of system development. Price increases are limited to a ceiling negotiated with the General Directorate of Consumption and Competition, and are determined by the inflation rate minus a percentage for productivity gain.

India: In India performance contract - or memoranda of understanding - are used at both national and state level to give incentives for improved performance by generation, transmission, and distribution utilities. For India's National Thermal Power Corporation, the performance contract specifies such desiderata as generation efficiency, forced outage reductions, and plant construction schedules. The incentive is increased funding and access to improved generation technology. In the case of the State Electricity Boards, performance contracts set out conditions for customer service, distribution loss targets, and reductions in load shedding in exchange for increased funding from the central government (and the World Bank). Participation by each SEB is voluntary.

Morocco: Since 1987 a new form of regulation has been introduced for the national power utility Office National de l'Electricité (ONE) which signs a 3-year renewable *contrat-programme* with the government. The contract owes much to the 1984-88 contract plan of EdF and ONE's objectives, and government obligations are portrayed in general terms. In the first 3-year contract, ONE undertook to satisfy its supply obligations at least cost within specified financial and economic parameters, and the Government undertook, *inter alia*, to raise tariffs to permit a minimum level of self-financing (30% after 1990), to grant greater financial autonomy and to contribute to the financing of ONE investment. The physical and financial performance indicators included: level of productivity of personnel, level of productivity of equipment, number of workers per installed kW in production, profit level of the grid, consumption of inputs, average level of value-added, rate of return on fixed assets, ratio of financial equilibrium, debt/equity ratio, debt service ratio, ratio of self-financing to investments, and level of investment financing by external loans.

Box 2: Sample of Management Contracts

Enterprise	Country	Contractor	Sector
Successful			
Manila Termina	Philippines	ISTSI (domestic)	Ports
Mumias Sugar	Kenya	Booker Tate (UK)	Sugar
Hino-Pak	Pakistan	Consortium (UAE, Japan)	Auto/truck assembly
Domestic Appliances	Pakistan	Al-Futtain (UAS)	Electrical appliance assembly
Guyana Sugar Corp.	Guyana	Booker Tate (UK)	Sugar
SONEG	Guinea	SEEG (Guinea and France)	Water
SNE	Central African Republic	SAUR (France)	Water
Shepheard Hotel	Egypt	Helnan (Denmark)	Hotel
Cairo Sheraton	Egypt	Sheraton (USA)	Hotel
Nile Hilton	Egypt	Hilton (USA)	Hotel
Sofia Sheraton	Bulgaria	Sheraton (USA)	Hotel
Hotel Stadt	Germany	InterContinental (USA)	Hotel
Sri Lanka plantations	Sri Lanka	Domestic contractors	Tea, rubber
Borderline			
Linmine	Guyana	Minprod (Australia)	Bauxite mining
Mount Kenya Textiles	Kenya	AMSCO (Netherlands)	Textiles
Naga Power Plant	Philippines	Ontario Hydro (Canada)	Electricity
State Gold Minig Co.	Ghana	Canada-Guyana Mining (Canada)	Gold mining
Light Rail (LRTA)	Philippines	Meralco (domestic)	Transport
Failures			
Nzoia Sugar	Kenya	Arkel (USA)	Sugar
Sanata Textile Limited	Guyana	SOE (China)	Textiles

Source: Bureaucrats in Business, World Bank Policy Research Report, 1995.

3.25 **Tariff Regulation.** The regulatory mechanism must ensure that tariffs are (a) regularly reviewed and (b) adjusted in accordance with sound economic and financial criteria.

3.26 Ideally, tariffs should:

- provide power producers with correct signals about the true economic costs of supply, thus encouraging them to make least-cost operating and investment choices,
- guide consumers to use electricity only to the extent economically justifiable, thus encouraging conservation,
- generate the internal resources necessary to maintain the sector's financial health and contribute to meeting its investment needs, and
- be affordable by as broad a segment of the population as possible, including the poor to whom electricity is being supplied more on social than on economic grounds

3.27 In practice, tariff regulators seek to approach these ideals by using adjustment criteria that focus either on financial results or on the cost of service. The more traditional approach is to adjust tariffs on the basis of such familiar financial criteria as rate of return on assets or contribution to investment. This approach has the double advantage of using well known and usually readily available financial data for tariff calculation, and of linking tariffs directly to desired financial outcomes. Its principal disadvantage can often be the granting of tariff increases on a "cost-plus" basis to power producers, giving them no incentive to improve efficiency and reduce financial costs to economically justifiable levels.

3.28 The other, more recent, approach is to link tariffs directly to the economic cost of supply, using marginal-cost or avoided-cost models. The avoided-cost model, for example, establishes the cost of energy and capacity at different times of day and in different seasons (important for a hydro-dominated system, such as Uganda's). To provide incentives for maintaining operating costs at efficiency levels, energy charges for hydro plants are adjusted with reference to O&M costs at the most efficient plants in the system while, for thermal plants, adjustment is made on the basis of cost indices determined by the most efficient fossil-fueled units. To promote least-cost development, capacity charges are adjusted to reflect changes in the cost of generating and other equipment required for system expansion using the best technology. The principal advantage of this approach is that it provides the correct economic signals to producers and consumers, and strong incentives for cost containment. The principal disadvantage is that the cost calculations can be difficult to make, and difficult to understand.

3.29 The choice of criteria for tariff adjustment may be less important than the establishment of a process for their application that is as transparent and as automatic as possible. To begin with, the criteria should be carefully defined, fully disclosed and clearly explained to the general public as well as to the effected entities. Secondly, a regular process for tariff review and adjustment, on at least an annual basis, should be established. Fixed periods of time should be specified for the various stages in the process, including the preparation and submission by UEB of tariff increase proposals justified in terms of the established criteria; review of the proposals by the regulatory authority; public comment and/or public hearings; and announcement of the regulator's findings. If tariffs are adjusted regularly according to accepted technical criteria, much of the political sting will be taken out of tariff adjustment.

Box 3: Price Regulation

Price regulation is the most important mechanism that governments have for rewarding or penalizing regulated monopolies. An ideal price regulating system will provide incentives to invest and improve service and will reward improvements in efficiency, while at the same time passing on the largest possible share of the resulting savings to consumers. In short, ideal price regulation will achieve outcomes very similar to a competitive market.

Schemes to regulate the price of basic infrastructure services include rate of return, price caps, and benchmark regulations. Each of these pricing schemes has its own incentive properties. Briefly, under rate of return regulation, prices are set so that the firm can recover its costs and make a fair rate of return. This scheme has been criticized on the grounds that it induces a firm to inflate costs, invest excessively, and engage in cross subsidization by shifting costs from services in which it faces competition to those regulated services in which it does not.

Price caps and benchmark regulations both potentially work better than rate of return in motivating producers to reduce their costs and pass some of the savings on to consumers. Under price cap regulation, regulators impose a ceiling, often based on the retail price index, on the average tariff increase for a pre specified basket of services in which the firm has a monopoly. The regulator can periodically change the pricing formula so that improvements in efficiency are passed on to the consumers. In theory, this avoids the problems inherent in rate of return regulation, since firms are protected from inflation and have no incentive to expand their asset base inefficiently; but, to the contrary, they can capture any benefits from improved efficiency that lowers costs below the price ceiling in the period between adjustments in the pricing formula. Benchmark regulation works on a similar principal, except that prices are set according to the costs of a similar firm elsewhere or a hypothetical efficient firm. Again, management has an incentive to improve efficiency, because the firm reaps the benefits until prices are renegotiated.

Strengthening the UEB

3.30 As already discussed, UEB's operational and financial problems lie largely in the areas of distribution and commercial operations. The persistence of high system losses and poor quality service despite the recent rehabilitation of the distribution system suggests that the problems are more than physical. Inadequate planning, leading to the haphazard growth of lines and connections, and the inadequate organization of maintenance appear to be among the root causes of poor performance on the distribution side. Similarly, numerous organizational and management shortcomings ranging from the lack of an accurate customer database to inadequate systems and controls for meter reading and cash collection, have been identified on the commercial side.

3.31 In 1994, UEB, working in close collaboration with the World Bank which had become increasingly concerned at the worsening of accounts receivable, adopted a series of "emergency" measures aimed at redressing the shortcomings in its commercial operations. These included appointing a new Chief Commercial Manager and having

him report directly to the Managing Director; reorganizing and decentralizing the Kampala District service function; introducing special collection and disconnection teams and creating and commissioning an independent unit to monitor their performance; and, perhaps most importantly, re-registering all customers in order to create an accurate client data-base. A consultant study in 1995[15] broadly endorsed UEB's efforts and recommended they be strengthened by, *inter alia*, merging the distribution and commercial functions; replacing the existing billing/collection system with a modern computer customer accounting system; and thoroughly revamping meter reading processes and procedures. UEB generally accepted the consultant's recommendations and adopted a monitorable plan to implement them.

3.32 While UEB has undertaken some remedial measures, they have been slow to take hold and they have not, as yet, shown any appreciable impact.[16] Receivables continued to rise in 1994 and the first quarter of 1995, reaching the equivalent of 8.7 months' billings in March, with the result that the target agreed with IDA of reducing them to the 3 months' level had to be abandoned. The slow progress and still uncertain outcome of UEB's ongoing efforts raise the issue of whether greater institutional change is required. Three change scenarios seem particularly worth exploring: contracting out UEB's distribution and commercial operations to a management firm; establishing a new distribution company separate from UEB; and contracting out the whole UEB to a management firm.

3.33 **Contracting Out Distribution and Commercial Operations**. This would involve contracting with a qualified firm to manage all or a part of UEB's distribution and commercial operations. This has been done by a number of utilities facing problems similar to UEB's including, for example, the distribution company in Ghana which has employed a European utility to run its billing, collection and customer service functions. The principal condition for success with contracting out, in addition to the selection of the "right" contractor, appears to be the negotiation of a contract that carefully spells out the contractor's authority and responsibility. The contractor must have adequate authority to manage --i.e., to make the changes in the organization, practices and procedures, and staffing necessary to make a difference. The contractor also needs to be held responsible for the achievement of specified, monitorable performance targets.

3.34 The principal advantage of contracting out is the placing of operations in the hands of new and experienced managers with responsibility for change who can, by signaling an end to business as usual, facilitate the introduction of changes (e.g., in staffing) difficult for the utility's own management to make. The principal disadvantage, in addition to the difficulties of contractor selection and contract negotiation, is the

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15 Customer Services Management Project, ESBI International Consultants Ltd., Dublin, Ireland.

16 As regards the re-registration of customers, for example, a 1987 study (Coopers & Lybrand) reported that "UEB had recently begun an enumeration of customers".

placing of function in the hands of others, a very difficult adjustment for any utility management to contemplate. The 1995 consultant study recommended against contracting-out for this reason, and also because it "....would be premature for UEB to decide on any contracting out option until it has modernized its system, procedures and controls in order to put these activities on a sound, efficient and controlled basis." However, this view appears to beg the basic question of UEB's ability to "heal itself" in the absence of the sort of change that would be involved in contracting out. Saying that contracting out would be premature until UEB has put its distribution and commercial functions in good running order is a bit like advising someone who is ill against calling in a doctor until he/she is well again.

3.35 **Establishing a Separate Distribution Company**. Creating a new utility for distribution is a more radical option but one which perhaps offers the best means of breaking with the past and creating an institutional environment conducive to change. Transferring responsibility for distribution and commercial operations to a new, specialized enterprise, would create a dedicated institutional base whose sole business would be reducing losses, improving the quality of service, expanding the distribution system along rational lines, and rectifying the critical need in billing and collections improvements. In such a company, distribution and commercial operations would cease to be the least glamorous and rewarding component of a multi-purpose organization, and a competent and competitive staff trained in these functions and looking toward them for career advancement could be created. A specialized institution could more directly and easily be held accountable for expanding service and for its quality and cost to consumers. The distribution company would buy power in bulk from UEB (or any other power producers). To succeed, it would have to be assured under the regulatory system of sufficient autonomy to charge retail tariffs that provide a sufficient margin over the bulk tariff to enable coverage of operating and investment costs.

3.36 Separating distribution from generation and transmission is a common arrangement throughout the world which has generally worked well where the distribution enterprise has had sufficient autonomy to operate commercially, and by imposing adequate tariffs. It is also an arrangement that can facilitate the entry of private power producers by providing them with a customer who is not also a competing producer. Drawbacks to this approach include the difficulty to break up existing institution and create new ones including the valuation and transfer of assets within a given time frame. Additionally separating distribution from generation and transmission may also encumber co-ordination in a small system, such as Uganda's.

3.37 **Contracting Out the Whole UEB.** While contracting out the distribution and commercial operations to private management or establishing a separate distribution company would have the potential of addressing key financial problems, these measures would not address problems in the operation, maintenance and development of the generation and transmission systems. Hence, a major disadvantage of contracting out only the distribution and commercial functions, is, that the generation and transmission operations of UEB would not benefit from it.

3.38 Therefore, it would appear more realistic to consider contracting out the whole UEB to a management firm or consortium. This approach would help avoid potential coordination problems between the distribution and generation/transmission functions. It would also address comprehensively all managerial, operational, and development planning problems of UEB; and at the end of the contracting out period, give to the Government a solid information basis to decide on the best institutional arrangements for reforming the power sub-sector.

C. PRIVATE SECTOR PARTICIPATION

Options for Private Sector Participation

3.39 The power sector clearly needs a great deal of technical, managerial and financial help. The traditional sources of such assistance to Uganda, bilateral and multilateral aid donors, have contributed a great deal but their impact has been limited and their resources are constrained. Other developing counties in similar circumstances have been turning increasingly to the private sector not only for a wide variety of contractual services but for the financing, construction and operation of major investment projects.

3.40 This section considers different options by which the private sector could take an active role in the development of Uganda's power sector as well as contribute to efficiency gains by imparting state of the art management skills transfer. Given the current size and condition of the Uganda power system, the most promising private participation options include: (a) provision of services; (b) decentralized power systems; and (c) independent power projects.

3.41 **Provision of Services.** In addition to contracting out the management of specific functions where UEB's performance is most in need of improvement (e.g., distribution and commercial operations), as already discussed, there are a wide range of ways in which Uganda can draw more heavily on the private sector for critical services. These involve according the private sector varying degrees of management responsibility. At one end of the spectrum lies the possibility of private sector management of the entire UEB operation under suitable contractual arrangements, as has been done elsewhere in Africa. Toward the other end lie the more limited, traditional services provided by the private sector such as: (a) employing consultants in line as well as advisory positions to fill key skills gaps (b) twinning arrangements, under which a suitable foreign utility would provide a team of experts to support UEB in specified areas over a number of year; (c) making greater use of contractors for operations that are now carried out by force account; and (d) turning over UEB's non-core activities (e.g., the provision of staff housing) to the private sector either through contractual arrangements or by privatizing (selling) them.

3.42 **Decentralized Power Systems.** Decentralized power systems are essentially smaller integrated power systems that are not connected to the grid. An

important feature of the African power sector is that there are many load centers in semi-urban areas located away from generation resources. Consequently, there is a niche market for private investments, both domestic and foreign, to set up community-based generation and distribution systems in these semi-urban areas. Such decentralized power systems may provide scope for the next wave of private investments in Africa in general and Uganda in particular.

3.43 **Independent Power Projects (IPPs).** Projects in which private investors, either alone or in conjunction with existing public utilities, finance, build, own and operate generating plants-- are an increasingly important phenomenon in many developed and developing countries. In the developing world, the main reason behind the growth of IPPs has been the inability of the traditional sources of capital --governments and aid donors-- to meet the growing development requirements of the power sector. IPPs have been moving in to help fill the gap, mainly in Latin America and in Asia, where they have been attracted not only to countries with large power markets that are considered good credit risks (e.g., China, Chile, Malaysia), but also to some smaller countries whose creditworthiness is more doubtful (Guatemala, Jamaica, Belize). However, the value of IPPs lies not only in their ability to raise significant amounts of capital but also on the fact that private participation brings with it the latest technologies and management expertise, and the assurance that plants will be completed rapidly and operated efficiently. While most IPPs have involved thermal plants, private investors have been showing increasing interest in hydro. IFC has approved financing for seven hydro projects and over twenty projects in ten developing countries are proceeding with private funding.

3.44 In most cases, private investors provide equity and debt financing for IPPs on a project or limited-recourse basis, relying on the prospective earnings of the project itself to repay their investments. While the investments are usually not directly guaranteed by governments, back-up or "counter" guarantees for the commitments of power purchasers, fuel suppliers and other public sector entities whose performance is critical to the success of the projects are often called for. Where country credit and/or other risks are seen as high, guarantees from bilateral and multilateral agencies may also be essential to the successful financing of at least the first IPP. The process of negotiating the numerous, interlocking agreements is often a long and difficult one.

3.45 Export projects are something of a special case. Since they earn foreign exchange, they can be set up on an "enclave" basis, the essence of which is that earnings are deposited abroad in escrow-type accounts from which direct payment is made to suppliers and creditors and to meet other obligations. Such an arrangement is usually very attractive to investors. Uganda has already moved towards IPPs when it signed a Memorandum of Understanding with a private investor group for the Bujagali project. To set up Bujagali along these lines implies the need for a trilateral relationship, with Uganda providing the site in return for royalties and or taxes on the IPP earnings; Kenya providing the market under the terms of a power purchase agreement, presumably backed up by performance guarantees; and the IPP agreeing to finance, construct and operate the

plant. While this is a familiar model, with two countries involved the negotiating process could be even more complex and protracted than is the case with other types of IPPs.

Enabling Environment

3.46 International experience with IPPs indicates the type of environment that would have to be created in Uganda to attract them. The policy frameworks in countries that have successfully attracted IPPs are anchored in the following fundamentals: (i) government commitment to private participation by articulating unambiguous support for private participation; (ii) mostly competitive bidding for IPPs because of transparency of the process and because competition attracts seasoned and committed developers willing to supply at attractive prices (the danger of negotiated deals is that they may produce high prices); and (iii) Government support to facilitate project development and financial closure.

3.47 In considering investment in the power sector, private financiers are mainly concerned with security and profitability. Security is likely to be deemed adequate only where there is a clear government commitment to private participation and where this has been spelled out through the establishment of a legal framework which explicitly encourages private entry, protects private investment and provides for the equitable settlement of disputes. A regulatory regime that provides clear rules of the game is essential for both security and profitability. To meet their concerns about profitability, private investors need to know that they will be able to charge realistic tariffs, that power purchasers (e.g., distribution companies) will be able to honor their contracts; that fuel will be regularly available at reasonable cost; that they will be able to repatriate their earnings; and that they will be able to exit the country on reasonable terms.

3.48 The creation of an environment attractive to private investors may seem a daunting proposition. Two facts need to be borne in mind in this connection. The first is that many of the conditions sought by private investors are, in any case, required for the efficient functioning of the power sector (e.g., transparent regulation and adequate tariffs). The second is that it has been possible to meet these requirements in a large number of countries, from China to Chile, having very diverse political, economic and social conditions through a combination of commitment and financial ingenuity. Thus, the term IPP covers a broad range of legal, financial operating arrangements designed to fit particular circumstances. For example, where selling to the grid has posed too great a market risk, projects have been structured to supply power to particular creditworthy industrial consumers (who may in turn be important investors in the project). Or, where fuel supply has appeared to be a major risk, energy conversion agreements have been devised under which the IPPs, in effect, earn a fee for processing fuel that is supplied to them (see box 4. on the Philippines experience). And, where an exit strategy has seemed essential to one or both parties, IPPs have been organized on a BOOT (Build/Own/Operate/Transfer) basis, which provides that investors shall recover their investment over a fixed period after which the project is transferred to the government.

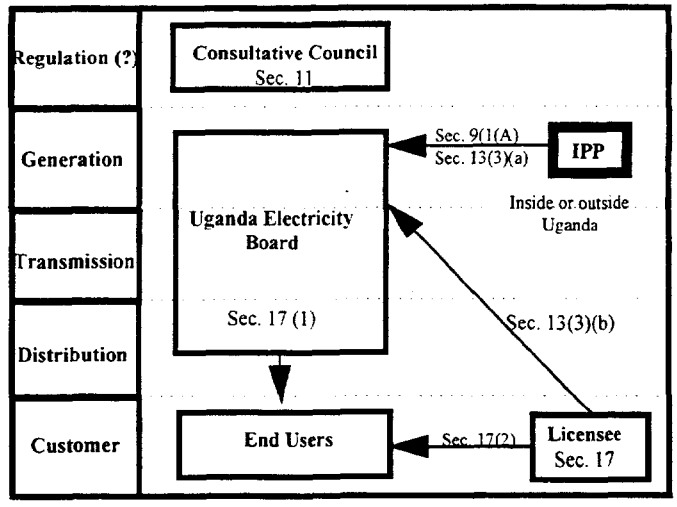
3.49 The process of finding out whether Uganda can in the near term attract private investment in the power sector will not be an easy one. While the necessary institutional arrangements need not be fully in place before trying to attract IPPs, certain minimum conditions must be established and, even when this is done, the process of stimulating investor interest, negotiating project arrangements and raising financing is likely to be difficult and time consuming.

3.50 However, given the pressing need for private capital, technology and management, this is a process well worth initiating. To do so, Uganda will need, first, to clearly and explicitly commit itself to private participation in the sector. The means that the Electricity Act will have to be revised to end UEB's monopoly status and clearly open the door to private investors, domestic as well as foreign. While the new legislation may contain minimum conditions for IPPs (e.g., concerning project feasibility and the credentials of the sponsors), it probably should not go beyond this since the government will need a maximum of flexibility in negotiating financial and other terms on a project-by-project basis. The Government of Uganda is in a process of revising the Electricity Act to clearly indicate its commitment to private sector participation.

Legal Framework

3.51 Uganda's Electricity Act does not, per se, appear to pose significant hurdles for private participation. The potential for private participation in Uganda's power sector is significant in both the generation and distribution parts of UEB. However, the mode of private participation in generation is different from that in distribution. That is, private participation in the *production of electricity* is possible through independent power producers, while private participation in *the provision of electricity* services is possible through either a performance based management contract or a lease arrangement with an option to purchase the existing system. The attached diagram, Figure 3.1, illustrates the scope for private participation under existing legal framework, which is codified in the Electricity Act of 1961.

Figure 3.1: Scope for Private Participation under Existing Power Sector Legal Framework



3.52 It appears that the Act has provision for sector regulation, private participation, and retail rate regulation. Some of the salient aspects of the Act are as follows:

- Section 3 of this Act re-establishes the Uganda Electricity Board (UEB) as a vertically integrated power utility with monopoly rights (Section 17 (1)) over generation, transmission, and distribution.

- Section 9 (a) allows UEB to "take electricity from any person inside or outside Uganda" and Section 13(3) permits UEB to enter into a contract "to take electricity from any person outside Uganda" and "to take bulk supply of electricity from a licensee" subject to Ministerial approval of the terms of the contract.

- The Act allows UEB to grant a "license" to generators with capacity exceeding 10 kW provided the electricity produced is used for the generating entity's own consumption.

- The Act also authorizes UEB to permit a licensee to generate and supply electricity to other users, in which case the UEB regulates the "manner in which electricity" is supplied, tariffs to be charged, accounting and auditing requirements, and recording and reporting requirements.

- The Act requires the establishment of a Consultative Council comprised of twelve members appointed by the Minister for an initial two year term with eligibility for reappointment. The Council is required to provide an advisory role to UEB and the Minister regarding issues related to electricity distribution, tariffs, and increasing access to electricity.

Although it appears that the Council is well positioned to act as an independent regulator of the power sector, the current Act does not provide the Council "regulatory teeth" The Council does not have any role in issuing "licenses", dispute resolution, or contract approval. However, to the extent a contract affects tariffs, the Council could be engaged in an advisory capacity.

- The Minister has a rather overarching role in the power sector: make regulations regarding electricity supply (Section 18(4)), dispute resolution {Section 19(2), Section 21 (3), Section 22 (3)}, eminent domain (Section 37(6)).

3.53 Although the Act does not "per se" appear to create barriers to private sector entry; the multiple roles of UEB as an "owner", "operator" and a "regulator" of the power sector has a dampening effect on investors' enthusiasm.

3.54 Because UEB has this "quasi" regulatory function, in that it issues licenses and regulates the operation of the licensees, there is a need for an investigation of the scope for separate regulation. One option for creating a separate regulatory entity would be to vest the Consultative Council the powers and authority to regulate UEB and decentralized power systems. At a minimum, the regulatory authority should: (a) establish transparent rules for setting prices, issuing licenses, and safeguarding the consumers' interests; (b) apply the same principles to all entities; (c) be an independent body and maintain an arms-length relationship with the government; and (d) provide adequate appeals mechanisms for disputes.

Regulation of IPPs

3.55 IPPs are regulated indirectly through the competitive procurement process as well as the Government's review of all the contractual documents. Essentially, IPP regulations can be through contracts and hence there is no immediate need for formal on-going regulatory review. Traditional cost-of-service regulation is bound to discourage private participation, and may indeed, make financing projects very difficult. However, the technical and engineering aspects of IPPs can and should be regulated. These requirements can and should be incorporated in the license issued by the regulator to generators.

Box 4: An Example of Private Power Project in the Philippines: the Navotas Gas Turbine Project

The Philippines offers a very good example of opening power generation to the private sector both in terms of number and variety of projects implemented. A key element of the rapid growth of IPPs in the Philippines was the enactment of an executive order in 1987 allowing the private sector to invest in electric power generating facilities, which included cogeneration, grid-connected plants, and plants located outside the national grid system that may sell power directly to end users. Since 1991, when the first IPP was commissioned, the state-owned utility National Power Corporation (NPC) has signed 33 agreements with the private sector, 13 of which were completed by the end of 1993. A total of 24 projects for about 2,500 MW were scheduled to be in operation by end 1994.

Five different schemes have been adopted: BOT (build, operate, transfer); BTO (build, transfer and operate); BOO (build/own/operate); ROL/ROM (rehabilitate, operate and lease/maintain); and OL (operate, lease). In most projects NPC has taken the fuel supply and cost risk through Energy Conversion Agreements (see below), and the market risk (through "take or pay" contracts) leaving the developer with only the project/country risk.

The Project

The first IPP contract in the Philippines was for the Navotas Gas Turbine Project. The project, a 210 MW gas turbine power plant, was commissioned in January 1991. The project, costing US $41 million, was developed by Hopewell Project Management Company Ltd. of Hong Kong using a BOT scheme and with limited-recourse financing (no government guarantees). The project was financed with equity from Hopewell, Citicorp, Asian Development Bank, IFC and with debt provided by ADB, IFC and a syndicate of commercial banks. The plant was built in twelve months.

Under BOT arrangements, Hopewell Energy Philippines Corporation (HEPC), a private company, owns and operates for twelve years and then will transfer full ownership and control to NPC. Under the twelve-year contract, HEPC supplies electricity to NPC. NPC provides the site, the fuel to the plant at no cost and pays HEPC for all the energy it takes. NPC pays a tariff consisting of a capacity fee and a fee for energy delivered from the plant.

D. System Development

3.56 Institutional change is a necessary but not a sufficient condition if Uganda is to have what it now lacks -- an efficient, reliable power system capable of expanding to meet the growing needs of the economy. Developing such a system will be a great challenge while the longer-term institutional arrangements are finalized. It will involve reducing losses and improving service; formulating a least-cost generation expansion plan; and building up the required capability to implement such a plan on time and within budget. However, the power sector also holds out great opportunity in the form of the long-term potential for developing a major export industry based on one of Uganda's principal resources, hydro-power.

Meeting Uganda's Needs

3.57 **Easing Current Constraints**. The power system has been running nearly flat out during the past 2-3 years. In 1995, UEB's energy production of 1,057 GWh and its peak load of 161 MW were close to the maximum capacity of the Owen Falls plant. This tightness was reflected in the need for regular load-shedding and in UEB's voltage

and other service problems already noted. The completion of work on the last two units to be rehabilitated at Owen Falls, which should be done by 1997, will provide some additional headroom over the next few years by raising installed capacity to 180 MW. However, definitive relief from capacity constraints will only come with the commissioning of the first phase (2x40 MW) of the Owen Falls Extension, hopefully in 1998.

3.58 While the completion of these two projects is the main item on UEB's current expansion agenda, its short term strategy, regardless of the institutional arrangements to be made, should also include mounting a major stop-gap effort to reduce technical and non-technical losses. Technical loss reduction could significantly increase UEB's ability to supply its customers with its existing resources. A 50 percent reduction in estimated technical losses, from 20 to 10 percent, would, for example, make some 85 GWh available to the market. To achieve this, a concerted program to strengthen the distribution network and its maintenance and operation is required. Such a program was prepared in 1992, and should be implemented. To reduce non-technical losses, UEB should complete the physical inventory of customers and update its customer database. (Annex 3.6)

3.59 **Load Growth**. The fact that UEB's current sales data do not provide a reliable indication of recent consumption trends, contributes significantly to difficulties in load forecasting. While the least uncertain consumption measure, "total supply" (Table 3.1) sent out to Uganda (generation minus exports), indicates some load growth, a good deal of demand may have been suppressed by the capacity constraint, suggesting that load growth could resume a rapid rate as and when this constraint is eased. On the other hand, since many consumers do not pay for their electricity currently, a more stringent billing and collection procedures could result in consumers cutting back on their use of electricity, thus shifting the demand curve downward. Because of these uncertainties, two simple growth scenarios illustrate the likely ranges: (a) 7.5%, a "high" growth rate but one somewhat lower than the rate at which total supply increased during the 1986-91 recovery period; and (b) 5.5%, a "low" growth rate reflecting the 1992-94 rate of increase in total supply.

3.60 As Table 3.2 indicates, under either scenario the energy and, especially, power balances remain tight until 1998, when the first unit (40 MW) of the Owen Falls Extension is expected to come on line. Thereafter, at the lower growth rate, the energy balance remains comfortably positive through 2004. However, at the higher rate, by 2004 demand is pressing close on supply. As for power, the Owen Falls Extension promises briefer respite. At the lower growth rate the reserve margin begins to fall below the comfort level of one 40 MW unit by 2000; and demand overtakes capacity by 2003. At the higher rate, the reserve margin becomes tight by 1999 and is gone by 2001.

3.61 To ease the supply constraints, there is also a need for drastic improvement in customer management to reduce wasteful consumption by consumers who are not planning to pay for their use. In addition, UEB should seriously investigate

whether energy efficiency and Demand Side Management (DSM) measures could be used as alternatives to capacity additions.

Table 3.2: Energy and Power Balances, 1994-2004
Energy Balance (GWh)

	1994	1996	1997	1998	1999	2000	2004
1. Production	1017	1100	1100	1363	1577	1577	1577
OF	1017	1100	1100	1100	1100	1100	1100
OF Ext.				263	477	477	477
2. Total Supply for Uganda	749						
5.5%		834	880	928	979	1033	1275
7.5%		866	930	1000	1075	1156	1537
3. Exports (1-2)	268						
5.5%		266	220	435	598	544	302
7.5%		234	170	363	498	421	40

Table 3.3: Energy and Power Balances, 1994-2004 Power Balance (MW)

	1994	1996	1997	1998	1999	2000	2004
4. Installed Capacity	171	180	180	220	260	260	260
OF	171	180	180	180	180	180	180
OF Ext.				40	80	80	80
5. Dependable Capacity*	153	162	162	202	220	220	220
6. Peak load	161						
5.5%		179	189	199	210	222	274
7.5%		186	200	215	231	248	330
7. Reserve (4-6)	10						
5.5%		1	31	51	50	38	(14)
7.5%		(6)	20	45	29	12	(70)

*Installed capacity minus one small unit, 1994-97; or one large unit, 1998-2004.

3.62 **Capacity Needs**. While strictly illustrative, these forecasts indicate that Uganda could need additional capacity before the year 2000, and is almost certain to need expansion of its system within a year or two thereafter, just to satisfy the requirements of the domestic market. By reducing power losses, capacity could be made available for

productive uses. Thereafter, capacity could be expanded at least-cost through the installation of additional units at the Owen Falls Extension, designed to accommodate five 40 MW units. However, this seems to require a change in the way water is managed at Owen Falls in order to ensure that the flow is adequate for the operation of the three additional units.

3.63 At the time of the construction of the original Owen Falls project, Uganda and the other riparians agreed that the plant would be operated so as to maintain the natural flow of the Nile --i.e., as if there were no dam. To implement this agreement, a so-called "Agreed Curve" was drawn up on the basis of historical data showing the relationship between the river flows and the level of Lake Victoria (Annex 3.7 and 3.8). Operating the plant according to the Agreed Curve means that a large quantity of water must be uselessly spilled, thus substantially restricting the generating capacity of the site. This has led many to urge that the Agreed Curve be re-negotiated to permit the dam to be operated as most dams are: to store water until needed at times of peak demand, and to permit the use of Lake Victoria as reservoir. Estimates as on how much this would increase generating capability varies, but 15-20 percent over what is possible under the Agreed Curve seems conservative. Such an increase would be roughly equivalent to 225-300 GWh/year.

3.64 It seems that a change in the Agreed Curve, to which the riparians must agree, will have to be made to permit the operation of the three additional units at the Owen Falls Extension. In 1990, Uganda informed the riparians that "(a) it proposed to build an extension at Owen Falls, and intends to continue operating the power plant and the dam so that the river has a flow regime as if the dam had not been built, but (b) to gain maximum benefits from the existing station and the extension and, in the absence of objections from any of the riparians, would change the operating arrangement to utilize the lake as a reservoir as was the intent when the dam was built." In 1991, Egypt responded that it had no objection in principle but that any change in the operating regime would have to be subject to negotiation. Such negotiations should be urgently pursued.

Export Potential

3.65 Uganda's vast hydropower potential could be developed for remunerative export markets, since there is not likely to be a need for a large-scale hydro development for the domestic market in the next 10 years or so if the Owen Falls Extension is expanded to full capacity. Though UEB now exports about 25 percent of its total generation Kenya, this export market is neither firm nor remunerative, since the exports are essentially a residual -- i.e., what is left over after the "needs" (including losses) of the domestic market have been met. Because UEB has had little capacity to spare, it has usually been able to export only during off-peak hours and so has been unable to meet its contractual obligations to Kenya. While Uganda agreed in 1964 to supply Kenya with 30 MW of firm power, in 1990-94 it actually exported no more than 17 MW. This presumably gave rise to little remorse on the Ugandan side, since the tariff agreed with

Kenya is a derisory $0.02/kWh. Exports to Tanzania, which began in 1994 (15 GWh), and to Rwanda which began in late 1995, are small but the price is right.

3.66 Uganda's future as an energy exporter could be much brighter. While Kenya is already exploiting all its hydro sites of any significance, Uganda has untapped resources that far exceed its needs so that the development of trade should be in the interest of both countries. To realize this potential, in addition to securing a change in the Agreed Curve, Uganda will need to (a) reach agreement with Kenya on the purchase of an economic quantity of electricity at an economic price; (b) identify a least cost site for development; and (c) make satisfactory arrangements for the construction, financing and operation of the new plant. While the Hydro Master Plan now under preparation should provide the necessary information about the various sites and their development costs, accomplishing the other two steps will not be easy. Given the prevailing relationship between Kenya and Uganda, and UEB's inability so far to secure a satisfactory price for its current exports, it is difficult to be sanguine about the prospects for negotiating a power purchase agreement. In addition, UEB's financial weakness and operational shortcomings mean that it is in no position to contemplate undertaking a major new project on its own account.

3.67 In these circumstances, Uganda's best hope of developing its export potential appears to lie in enlisting the assistance of the private sector. The fact that one independent power producer has already expressed interest in constructing and operating a large plant at Bujagali lends credence to this prospect, which is discussed further below.

E. EXTENDING ELECTRIFICATION

3.68 As already noted, the benefits of electricity are today available to only a small fraction of the population living in the capital and the larger towns. This is all too typical of the situation in many African and other developing countries where the scope for electricity service is narrowly constrained by low income levels and the shortage of resources. Even within these constraints, however, there is much room for improvement. Rough estimates prepared for the Assessment (see Annex 3.9) suggest that the number of people who could afford electricity and have homes suitable for the installation of electrical service is more than double the number presently served. Given the critical role that access to electricity can play in economic and social development, the extension of electrification warrants high priority in the government's development efforts.

3.69 The requirements for extending service are best viewed by distinguishing between "urban" and "rural" electrification --i.e., between areas already served by the grid or located close to it, and areas remote from the grid that are unlikely to be reached by it in the foreseeable future.

3.70 **Urban Service**. In urban areas the basic task is one of strengthening and extending the existing distribution network. While UEB has been rapidly increasing the number of connections to its system, this has often been done in an unplanned, ad hoc

(not to say haphazard) way that has further overloaded the system --e.g., by excessively extending low voltage lines. The 1992 distribution study made detailed recommendations for improving planning and design. This study needs to be re-visited and up-dated with a view toward preparing a technically and economically sound distribution rehabilitation/expansion plan covering, say, a five year period. Such a plan would, identify and cost the most economic line extensions, prioritizing them in accordance with their economic returns. It would thus provide UEB with guidance on the level of investment that is economically justified and on the most rational allocation of whatever investment funds become available.

3.71 **Rural Service**. The electrification of areas remote from the grid, where the bulk of the population live, is quite a different matter. UEB has no plans for rural electrification and it is unrealistic to think that more than a tiny fraction of the rural population could be reached by the conventional, utility extend-the-grid approach. A more promising course is to rely, instead, on "alternative", "non-conventional" or "complementary" approaches to rural electrification --i.e., on the wide variety of possible means by which rural communities and families can be provided with, or obtain for themselves, some form of limited alternative electricity supply pending the arrival of a conventional service. Such rural electrification is now taking place on an extremely limited scale in Uganda.

3.72 In Uganda, as in many developing countries, however, a variety of entrepreneurial or self-help methods of providing small scale electricity supplies to rural families have emerged. These include small privately owned generators running on diesel, gasoline or kerosene to provide supplies to households, commercial enterprises, small industries, workshops and farms and car batteries to provide small amounts of electricity for lighting, radio, and even television.[17] Although the electricity supply provided is minimal, it clearly meets a strongly felt need among rural and peri-urban families unable to obtain a conventional supply. It also includes the use of solar photovoltaics (PV) and other renewable energy systems for domestic and other small scale uses as discussed in Chapter 4. The private sector appears to have taken the lead in photovoltaic electrification. Several thousand PV units have been reportedly installed in private homes over the past few years. Given Uganda's favorable solar radiation levels, photovoltaic technology has the potential to provide power to even larger numbers of homes and institutions, and its use should be actively encouraged.

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[17] Car batteries are widely used by rural and peri-urban families throughout the developing world. They are recharged for a fee at recharging centers where the electricity is obtained from the grid or a diesel generator. Their widespread use is reported from Kenya, The Gambia, Senegal, Sri Lanka, the Yemen, Peru and a variety of other countries. The batteries are usually standard 12 volt car batteries with capacities in the range of 60-120 Ah, but in some countries purpose-designed batteries are used. In Sri Lanka, for example, a system known as the Prasakthi unit was designed by the National Engineering and Research Center in the middle 1980s and sold at $27. In Zimbabwe, a commercial firm produces a 14 Ah battery with a specially-designed warning system to help prevent excessive discharge which shortens the battery life.

3.73 In addition, small private decentralized supply systems are found in a variety of other developing countries and appear to emerge spontaneously where there are no legal obstacles to the provision of such supplies. A 1986 World Bank study found, for example, some 17,000 small private electricity supply systems in Indonesia.

3.74 The coming into use of these small scale electricity supply systems represents a significant mobilization of private resources in the rural areas. It also enables rural families to obtain some of the key benefits of rural electrification in areas which cannot presently be reached by conventional rural electrification. As such, these approaches deserve to be encouraged by the Government as part of its efforts to improve rural living standards. This means, essentially, legally opening the market to private, small scale suppliers; adopting no-hassle licensing procedures; removing other bureaucratic obstacles; and enabling private suppliers to charge whatever tariffs the market will bear.

4. RENEWABLE AND TRADITIONAL ENERGY

4.1 Uganda is richly endowed with renewable energy resources including plentiful biomass and hydrological resources, favorable solar conditions, and large quantities of agricultural residues. With the exception of biomass, Uganda utilizes only a fraction of its renewable energy resource potential. Considerable Government, donor, NGO and private sector interest has been shown over the past fifteen years to develop Uganda's renewable and "traditional" energy sector.[18] Unfortunately, these efforts have generally been uncoordinated and ad hoc. Frequent changes in Government administrative responsibility have led to duplication in activities and inconsistencies in terms of programs, projects, and policy development and implementation.[19] The Government is now making an effort to redress past inconsistencies, and to develop a comprehensive energy policy which will foster sustainable economic growth. The principal issues the Government needs to tackle in the renewable and traditional energy sector include:

- **Co-ordination and Rationalization of Programs.** Establishing verifiable indicators from past activities to form a sound basis for future activities and investment.

- **Off-Grid Electrification**. Encouraging decentralized grids, and the use of solar photovoltaic and mini-hydro technology and making greater use of the private sector.

- **Sustainable Supply**. Examine the policy framework for forestry production in an effort to encourage private tree planting and private forestry expansion to promote woody biomass as a cost-effective and sustainable national resource.

- **Efficiency in Charcoal Production and Biomass End-Use**. Disseminating skills and techniques to improve charcoal production methods, improving charcoal and wood stove technologies, and improving efficiency in agro based industries.

- **Biogas Program**. Recommending an end to biogas programs due to the present economic constraints of biogas as a viable energy option.

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[18] The term "traditional" is used here to refer primarily to biomass fuels used in a traditional way, mainly in domestic/household and informal sector applications.

[19] The energy portfolio was downgraded from ministerial level to departmental level in 1992. As shown in several presentations to Parliament, the Department of Energy has lost numerous staff, and has had major problems of retaining trained staff.

Each of the above issues are discussed below after a review of biomass supply, consumption and prices.

A. BIOMASS SUPPLY, CONSUMPTION AND PRICES [20]

4.2 **Supply**. Biomass, principally fuelwood and charcoal, is in quantity terms the most important energy source in Uganda, accounting for about 90% of primary energy supply. Current work under the Uganda National Biomass Survey (NBS)[21] points to localized problems in supplies under the present economic and forestry policy regime, despite the country's physical and agro-ecological potential to supply biomass at current aggregated levels of demand.

4.3 The Energy Assessment Mission estimated the annual sustainable supply of biomass on the basis of the preliminary results of the NBS at about 29 million tons, which is equivalent to approximately 8 million tons of oil (Uganda's total annual energy consumption is equivalent to some 5 million tons of oil.). Wood accounts for 72 percent of the total, with crop residues providing 18 percent and dung 10 percent. (Table 4.1). Annex 4.1 provides additional details of estimated biomass supply.

Table 4.1: Estimated Annual Sustainable Supply of Traditional Fuels, in 1993

	Million Air dry tons	Percent
Wood Biomass	21.0	72.0
Residues	5.4	18.5
Animal Dung	2.8	9.5
Total Supply	29.2	100

4.4 Of the estimated total annual supply, **woody biomass** such as bushlands provide 30 percent and woodlands 20 percent. Agricultural areas provide the balance, half coming from fallow land and the other half from arable lands, mainly small farms. Tropical high forests supply 2 percent of annual yield, but because most of these forests

[20] The discussion below focused on biomass. Hydro and solar energy issues are discussed in section E under off-grid electrification and biogas is discussed in section F. Wind energy is currently used in limited extend for water pumping. The economic potential of wind energy for large scale applications would have to be assessed in a separate study.

[21] The NBS is an inventory of woody biomass and crop residues which is being undertaken with the support of the Norwegian Forestry Society.

are away from population centers, they are not a significant source for fuelwood or charcoal. Most fuelwood and charcoal come from woodlands, bushlands and farmlands.[22] It is likely that the estimated supply is on the low side, because the nine regions the mission used as a basis for the estimates are areas under stress and contain major urban centers[23]. It is therefore possible that the final NSB estimates may be slightly different.

4.5 The annual yield of **crop residues**, which is approximately the same as the growing stock (because they come from annual crops) is over 5 million tons, 90% of which is from farm land. Demand surveys indicate that very little crop residues are burnt in households. The use of residues is more widespread in industries. For instance, the sugar industry uses bagasse and a clay factory in Kampala uses coffee husks, although much more could be used. No estimate of **dung** production has been made in the NSB, for it is not burnt as a fuel. Calculations using the Ministry of Agriculture's 1990-1991 data for the number of domestic animals, place the estimated dung production at just over 3 million tons, which is equivalent to about 2.8 million tons of air dry wood.

4.6 **Consumption**. Woodfuels provide the energy for cooking and water boiling for most rural and many urban homes. They are also important for rural industry, especially for the production of building materials, such as bricks, and commercial enterprises in urban areas, such as restaurants and bakeries. The reliance on woodfuels is expected to continue for many years to come, given the high prices of petroleum fuels and the limited availability of electricity. The mission estimates that the total woodfuel and biomass consumption was around 16 million tons of fuelwood equivalent (tof) in 1994. Table 4.2 provides a break-down of the consumption figures and Annex 4.2 provides further details.

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22 According to Plumtree and Carvalho, (Deutsche Forest Consult 1991), the 1991 estimated demand for sawlogs is 190,000 m^3, which in weight terms is about 130,000 tons. Tropical High Forests (and plantations) can easily sustain this demand, so logging is not causing deforestation, although it may be causing some degradation. The principal cause of THF deforestation is clearing for agriculture. In order to slow down the deforestation rate, agricultural productivity must increase, and farm trees could play a role in this.

23 Two other estimates have been made of woody biomass. One was based on the analysis of satellite imagery for Africa with very little ground truthing, (World Bank 1993). It estimated the growing stock and yield in Uganda to be 981 million tons and 80 million tons respectively. The other was made by the Ministry of Agriculture and Forestry in 1988, based on the estimated growing stock and yields from different land use categories. The estimated growing stock and yield is 550 million tons and 19 mill. t. respectively. Both of these two estimates neglect the short rotations of "bush" wood in the yield calculations.

Table 4.2. Estimate of Consumption of Woodfuels and Biomass, 1994

Location	*1994 Consumption estimates—all sectors ('000 tons fuelwood equivalent)*				
	Crop residues	Collected	Purchased	Charcoal	Total Wood
Rural	981	11,527	151	304	12,963
Urban - non Kampala	19	245	197	944	1,404
Kampala	1	47	69	1,424	1,542
Total	1,001	11,819	417	2,672	15,909

Sources: Mission estimates. (see also Annex 4.2).

4.7 **Biomass Supply/Demand Balance.** The estimated sustainable supply of biomass is almost twice the level of demand for Uganda as a whole. While these estimates must be considered with caution, they indicate that fuelwood supply problems are not country-wide but localized. Indeed, concern that urban demand for charcoal and fuelwood is leading to environmental destruction, especially around the highly urbanized areas beside Lake Victoria, have been partially confirmed. The preliminary NBS results indicate that the local available supplies of woody biomass are not adequate to meet demands in major urban centers. Wood have to be imported from other regions. On the country-wide level, however, using the Mission's estimate of demand growth, at 3 percent per year, a supply surplus should persist well into the next century. This analysis accounts for other uses of wood, such as construction, and for some conversion of woodlands and forests to agriculture.

4.8 **Comparative Energy Costs.** Energy cost comparisons carried out by the mission indicate that biomass is often the least expensive energy option for both households and energy-intensive industries. Many urban households that responded to the Pilot Survey mentioned that they were cooking with electricity before the electricity tariff hike in the summer of 1993, but switched to charcoal because electricity became expensive. Table 4.3 shows that the cost of cooking with electricity is roughly double that of cooking with charcoal. Since the prices of woodfuels and electricity reflect their economic costs of supply, the reported substitution away from electric cooking to charcoal in urban areas serves to remove uneconomic cooking demand from the electricity system.

4.9 As may be expected from the relatively high cost of petroleum products, cooking with paraffin and LPG is 3 to 4 times more expensive than wood or charcoal. Even if duties were eliminated on paraffin and LPG, displacement of woodfuels by paraffin and LPG would double urban household fuel expenses.

Table 4.3: Comparative Urban Cooking Costs in Central & Eastern Uganda, 1994

	Unit	Heating Value	Stove Effic.	Fuel Cost Ush/unit	Fuel Cost USh/Utilized MJ	Annualized Stove Cost Ush	Total Cooking Cost USh/Utilized MJ	
		(MJ)	%	Financial	Financial	Financial	Financial	Economic
Fuelwood								
Traditional stove	kg	16.0	17	63	3	0	23	23
Improved stove		16.0	25	63	16	5,000	17	17
Charcoal								
Traditional stove	kg	30.0	25	112	15	2,500	15	15
Improved stoves		30.0	30	112	12	6,854	13	13
Paraffin	liter	34.1	45	889	58	5,576	59	44
LPG	kg	45.2	55	1,778	72	21,053	74	39
Electricity	kWh	3.6	70	70	28	7,925	29	29

Notes: See Annex 4.3 for assumptions.

4.10 Uganda has two cement plants, one in Tororo and one in Hima. Both plants are gearing up towards previous (pre-civil strife) production levels but are hampered by the high cost of fuel, which accounts for a major proportion of the final cost of cement. Until the 1970s, the Tororo plant used about 17,000 tons of charcoal annually, which it imported from Kenya. It has now switched to fuel oil. When these two plants have completed their rehabilitation and expansion according to current plans, their energy demand will be on the order of 375,000 GJ per annum, or the equivalent of over 120,000 tons of coal, or a similar quantity of charcoal. Because energy is such an important cost element, it will be crucial to carefully evaluate how to meet the plants' future energy needs at least cost. According to the data the Mission compiled, oil would the most expensive option. Imported coal from South Africa is the next most expensive option, while charcoal produced in a sustainable manner from wood grown at private plantations appears to be the least expensive option. Table 4.4 compares these three options.

Table 4.4: Comparison of Energy Requirements and Costs for Cement Production Hima and Tororo Cement Plants under Full Production Assumptions

Item	Charcoal	Coal	Fuel Oil
US$/tonne delivered	$54	$100	$375
Energy (GJ/tonne)	30	30	42
End-use efficiency	50.0%	50.0%	65.0%
Energy demand (GJ/yr)	3,750,000	3,750,000	3,750,000
Energy demand (tons/yr)	125,000	125,000	89,286
US$ cost per yr	$6,793,478	$12,500,000	$21,763,393

Source: Tororo Cement Plant, Shell Oil Company, UPET, Ministry of Finance and Economic Planning ("Annual Statistical Bulletin - 1994", "Census of Manufacturing Enterprises: 1989 (updated 1994)", "Background to the Budget 1994-95"), ESD field surveys and interviews.

B. Coordination and Rationalization of Programs

4.11 Renewable energy development received much attention in Uganda and as a result many pilot activities have taken place. However, lack of coordination, little exchange of information and experiences, limited follow-up, and very limited monitoring and evaluation of these projects and programs has occurred. Therefore, the actual contributions to the country's development of these projects and programs remain unclear. Much duplication of effort, ignorance of previously established baseline information, and the "reinvention of the wheel" has resulted from this state of affairs. This is unfortunate, as traditional and renewable energy can continue to contribute substantially to economic development in Uganda.

4.12 It is therefore suggested that all previous household and renewable energy projects and activities be inventoried and analyzed in an in-depth study. Stock should be taken of all activities to rank results, outputs and critical success factors. The objective of this exercise should be an attempt to establish some objectively verifiable indicators of what has worked and what has not to help form a sound base for future support and investment by prioritizing projects and investments, on which basis donor support can be channeled. The study should compare in-country projects and programs to similar studies and projects already enjoying regional success, as well as the comparative successes of intra-country activities. The private sector, particularly in the charcoal production, agro-forestry and photovoltaic sectors, should be invited to contribute their expertise This study could then provide the Government and all interested parties with a framework to encourage the rational, economical and environmentally sustainable development of traditional and renewable energy in Uganda.

4.13 The above activity would also contribute to building the well needed analytical capability at the MNR for policy and strategy formulation in the areas of traditional and renewable energy.

C. Off-Grid Electrification

4.14 While Uganda has plentiful hydropower, solar and biomass resources, it has one of the world's lowest levels of electricity development. However, considerable scope exists for accelerating electrification. The country's rural cash economy is growing rapidly and with it the demand for power. Some of this demand is currently met by small petrol and diesel generators, and photovoltaic systems. While no studies have been undertaken in this area, it is estimated that considerable suppressed demand for power exist as Uganda's rural cash economy rebounds after years of stagnation. As experienced in other countries, such as Kenya, many rural and peri-urban households, industries and commercial establishments are willing to invest in obtaining electricity.

4.15 It is unrealistic to think that more than a tiny fraction of the rural population could be reached by the conventional approach of grid extension. A more promising course is to rely, instead, on alternative approaches to rural electrification.

Opportunities exist for developing small-scale hydropower, solar photovoltaic systems, biomass, and co-generation by sugar and tea factories to provide electricity. Potential for private participation in the provision of these services is significant. To unleash these opportunities the Government needs to explicitly encourage private entry. To meet concerns about profitability, private investors need to know that they will be able to charge realistic tariffs, particularly in rural and peri-urban areas, where the costs of electricity supply may exceed that of the grid system (see Chapter 3). Faster development of electrification could also be achieved provided the Government allowed less strict standards for power generation and distribution in rural and peri-urban areas.

4.16 **Mini-Hydro**. Uganda has large unexploited hydropower capacity on both the Nile and Zaïre River watersheds. Numerous sites for the possible development of small and micro hydropower have been identified. Yet, with the exception of the Mokobu and Kabale small hydro-electric stations, almost nothing has been done.

4.17 **Solar Photovoltaics**. The private sector is the major player in the development of solar resources in Uganda. An estimated 3,500 photovoltaic household units have been installed over the past eight years entirely by the private sector, without donor or government support. An estimated 2,000 photovoltaic units had been sold for private use (e.g., rural household lighting, livestock fencing, etc.) over the last three years only. In addition, NGOs have installed over 300 solar systems (ranging from solar refrigerators to solar units for lighting and water pumping), and the rapidly growing tourism sector is expanding its use of photovoltaics in and around parks and reserves. Solar water heating systems have been tested on a pilot basis and have been placed in many tourist lodges.

4.18 Projects are currently being put forward by Government, by donors and NGOs, and by the private sector. By removing tariffs and duties on photovoltaic panels in the 1995 tax bill, the Government indicated its commitment to promoting the use of photovoltaics. However, this policy should be streamlined to remove remaining impediments: inverters are still subject to duty and imported batteries are subject to heavy duties. Although extensive regulation should be avoided to promote increased private sector involvement, system quality standards should be developed and the information disseminated to discourage unscrupulous suppliers.

4.19 **Biomass**. Off-grid development need not be restricted to hydropower and photovoltaic technology. Biomass already provides electricity in the sugar and tea industries. Uganda's plentiful biomass supplies, including coffee residues, bagasse and wood, could potentially provide the energy to raise steam for power generation. The viability of using biomass for power generation should be examined. In addition, some industries may be able and willing to sell their excess power either to the national grid or to surrounding dwellings and institutions.

4.20 **Decentralized Power Systems**. Decentralized power systems are essentially smaller integrated power systems that use, generally, renewable resources to

generate power and that are not connected to the grid. As discussed in Chapter 3, there is a market niche for both foreign and domestic private investment, to set up community-based generation and distribution systems in semi-urban areas.

D. Sustaining Biomass Supply

4.21 While the overall wood and other biomass supply is in excess of demand, some densely populated regions are experiencing shortages. The size and extent of these shortages cannot be determined without a national energy supply and demand survey. The Household Energy Planning Program (HEPP), undertaken in 1989-1990, was intended to be a comprehensive study of household energy issues and options in Uganda which would provide the basis for designing a household and biomass energy strategy. Much of the work performed by the HEPP team, especially the stove field trials and charcoal kiln review, was of quality. However, the household energy demand survey was very inadequate and could not be used as a basis for planning. In addition, the HEPP study failed to build analytical capability for policy formulation within the Ministry. To obtain up-to-date information and to complement the HEPP and NBS studies, the Government could consider a small integrated household/renewable energy demand and supply survey, which should include not only biomass, but all forms of renewable energy. However, even without detailed data, efforts could be designed, based on experience in other countries and past experience in Uganda, to ensure sustainable supplies to meet future demands.

4.22 **Rationalizing Biomass Supply**. With the population growing rapidly and little disposable income to switch to modern energy, demand for biomass will continue to be high. The Government should examine the entire policy framework for forestry production in an effort to encourage private tree planting and private forestry expansion to promote woody biomass as a modern, acceptable, cost-effective and sustainable national resource. Particular efforts could be made to provide incentives for increased private farm tree planting. This would not only produce wood and wood products for sale but would also help increase agricultural productivity. Some initiatives are already underway, but an increase in the level of the effort is required, including: (a) clarification of land tenure and allocation of bushland and woodlands to cooperatives and/or individuals; (b) an adequate supply of seedlings from good seed sources; (c) demonstration units showing farmers the benefits of silviculture, and making market data (present and future demand, supply and production costs) available to them; (d) agro-forestry/forestry and environmental training for farmers, and education in schools and institutes of higher learning; and (e) reforming the Forestry Service.

4.23 To provide incentives for increased private sector farm tree planting, **land ownership and security of tenure**, should be clarified. Well-defined property rights are crucial for farmers to make long-term investments in agriculture and silviculture. Non-gazetted "government" woodlands and shrublands could be allocated for agricultural development or as forest land. The ownership of forest lands should be investigated with a view to selling or leasing some to communities, companies or individuals.

4.24 The provision of **good seed strains** can increase tree productivity and health considerably. Many existing tree seeds both in the public and private sectors are of dubious provenance and quality. Certified seeds should be made available to farmers and schools. Advice and instruction should be given on direct sowing, nursery practice and planting out.[24]

4.25 To encourage farmers to plant and manage trees for sale, training and **demonstration** on the practice of silviculture should be undertaken. Farmers should have access to farm gate prices, market demand for the various wood and tree products, growing, transport, and production costs, and delivered price estimates. Market data on industries using wood and other biomass energy should be collected and made available to the rural producer.

4.26 Extension efforts and **training** should be expanded to teach management of existing biomass resources. The teaching of tree planting and management, energy conservation and environmental awareness has been proposed for schools and a syllabus is being drawn up for a pilot project in 15 schools. This initiative should be supported with equipment, funds and facilities for teacher training. Yield from existing tree resources could further be improved if simple techniques were taught to farmers, charcoalers and wood cutters; and appropriate (hand) tools to cut and prune the trees were made available.[25]

4.27 **The Forestry Department** has three principal functions, namely the commercial production of forest products; advising the government on policy matters; and providing advice and services to people. To perform these functions it relies on budgetary support from the Government, to which proceeds from the sale of forest products are handed over. Because the revenue from fuelwood and other forest products sales should be adequate to run the commercial section as a self-financing enterprise, the Government should investigate whether parts of the commercial sector of the Forestry Department could be sold or leased to communities, or the private sector.

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[24] As part of the donor sponsored "Forestry Rehabilitation Project" a Farm Forestry project was supposed to establish over 1,000 nurseries in 26 districts for the production of 27 million "farm" seedlings annually. This project, valued at US$7.7 million was to be jointly run by DANIDA and CARE. This project ran into administrative problems and DANIDA withdrew, leaving only US$0.2 million. A similar initiative is still required, but the emphasis should be changed to direct sowing of tree seeds and farmers raising their own seedlings with perhaps a surplus for sale.

[25] Many woodland trees regenerate naturally from stems and roots by coppicing. To encourage coppicing, trees should be cut at a specific distance from the ground, preferably with a saw rather than an axe, and the coppice regrowth should be reduced to encourage one or two vigorous stems. There is also a preferable season in which to cut the wood. Likewise in order to encourage natural regeneration, animals should be excluded in the formative years. Similarly, different species have different rotation ages for maximum yield production, but this should be tempered to market demands.

E. IMPROVING THE EFFICIENCY IN CHARCOAL PRODUCTION AND BIOMASS END-USE

Improving Charcoal Production

4.28 The production of charcoal is a large-scale economic activity. It employs perhaps 20,000 people on a full-time basis. Located in the rural areas, it generates possibly over USh 16 billion every year (over US$17 million), with a quarter of that going to rural land holders, half to producers and another quarter to local authorities and Government in taxes and revenues. In addition, a large number of people are employed in transporting, distributing and marketing charcoal. This makes charcoal an important rural cash commodity. Even more benefits could be derived, if the current production methods - use of inefficient traditional earth pit kilns that require damp soils, and constant tending - were improved.

4.29 There have been many efforts to improve the efficiency in charcoal production. The Government and the donor community have initiated several programs since the late 1960s. In addition, every forestry sector support program since 1981 has sought to address the need to improve efficiencies of charcoal production through training, technical assistance, improved tools, and credit. Nevertheless, few results can be seen today from these efforts, largely because the efforts have not reached a critical mass of charcoal producers.

4.30 A major problem for disseminating techniques for improving the efficiency in charcoal production is that most charcoal (over 70%) is produced by dedicated, itinerant charcoalers (i.e., people engaged in charcoal production full-time, as their sole or major economic activity) on an independent basis. If, however, the producers were organized so that they could be reached more easily with needed training and skills, in harvesting and production techniques -- e.g. improving kiln construction, firing, and tending practices -- efficiency improvements of charcoal production on the order of 30 percent or more could be achieved. Since charcoalers are often lacking in investment capital, they do not have spare cash available for purchasing materials needed for improved kilns. A revolving fund to finance kiln materials, therefore, would address a substantial barrier to effective dissemination of improved methods.

4.31 Additionally, a kilns program along the lines of that described in the HEPP study would result in 1/3 of all charcoal consumed in Uganda being produced in kilns that are twice as efficient as traditional methods. Such a program would attempt to replicate the experience of the most successful improved-kilns dissemination efforts in eastern and central Africa. This target may not be out of reach as a great deal of improvement can be obtained from existing earthen kilns by training charcoalers in best-practice techniques. This should interest charcoalers, as it would increase yields from each charge and effectively raise their incomes. A detailed evaluation of this program, in Annex 4.4, shows that it should yield a high rate of return on investment.

Improving Household, Institutional and Industrial End-Use Efficiency

4.32 There are significant opportunities for improving end-use efficiencies in households, institutions as well as in industrial and commercial enterprises. Reduction by a third of consumption should be possible through efficiency improvements at points of consumption. While little external support has followed from several donor-sponsored studies on end-use efficiency, the private industries has moved forward on their own. The priority for Government action in this area is to carefully review all previous efforts particularly relating to dissemination of energy efficient or "improved" wood and charcoal stoves, identify the critical success factors and replicate successful programs.

4.33 **Charcoal Stoves**. Charcoal is mainly an urban cooking fuel used by more than 1.5 million households and commonly burned in a traditional metal Sigiri, with an average efficiency of about 24 percent. At least eighteen separate projects, project components and/or programs have been undertaken on improved stoves since 1984. Unfortunately, "little concrete or long-term benefits have resulted from these efforts."[26] A number of improved charcoal stoves with efficiencies around 30 percent were introduced by NGOs in the 1980s, spurred by the success of similar programs in Kenya. In Uganda, however, the results have been marginal. The Assessment Mission estimates that only about 15 percent of homes in Kampala use improved charcoal stoves and only some 10 percent of households outside of Kampala. The fall of relative charcoal prices may have contributed to the low saturation rate of improved stoves in urban households. Yet, low-income households spend as much as 10 percent of their income on fuel, and the improved stoves could pay for themselves in charcoal saved over very short periods.

4.34 Because of lack of quality control, monitoring and testing, the actual performance (i.e., energy efficiency) of stoves in households is not known. Stove quality varies, and consumers have limited possibilities to assure themselves of performance. Recent tests by the Forest Department indicate this clearly: at least one stove model is being sold to consumers as improved despite its being less efficient than the traditional Sigiri stove. In an effort to promote greater use, there should be a real attempt to provide incentives for quality stove production. Technical and testing results for improved stoves could be disseminated and the stove testing by the Forest Department should continue. Public education may also help.

4.35 **Wood Stoves**. The three-stone fireplace, the least efficient technology for consuming fuelwood, is common throughout Uganda. These stoves also contribute to indoor pollution and consequently to women's' and children's' health problems. As with improved charcoal stoves, at least ten donors (NGOs and bilateral agencies) have tested and promoted improved wood stoves, primarily for rural dwellers. Wood stove trials and dissemination have mirrored charcoal stoves in that most of the designs are modeled on

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[26] Ministry of Natural Resources, "Presentation to the National Resistance Council (Parliament) in 1994-95 'Background to the Budget'".

Kenyan examples. All wood stove donor efforts have been components of wider programs such as settlement schemes, agricultural extension programs, women's projects and health programs. These projects seem to have produced meager results: rural and urban households outside of Kampala interviewed for the Pilot Survey[27] used three-stone fireplaces exclusively to burn wood and crop residues. In addition, the HEPP survey and the Pilot Survey both indicated that only 15 percent of the wood stoves in Kampala were improved. These findings may indicate that wood users are generally not too concerned about wood scarcity, or that the stoves that were introduced were not appropriate for the local cooking practices. Moreover, given that most rural households collect rather than buy their fuel wood, the incentive to use efficiently is not great.

4.36 On a more promising note, the Joint Energy-Environment Program, an NGO funded entirely by a Dutch charitable group, appears to be approaching improved rural stove dissemination the right way. Between March and November 1993 they trained 176 stove builders who built over 11,000 stoves. The concept was to train trainers in stove building and kitchen practices who would then disseminate these skills in their own villages. Some villagers reported that prior to stove use and improved practices, a 7-member household would consume 5 bundles of wood every two days, but with the improved stove, the time period was extended to five or six days. Program staff reported that the program was most successful in areas of scarce fuelwood (and high fuel costs), where the population had cash enough to pay a small fee to the stove builder. The stoves are constructed out of mud/clay and other gathered materials, and were therefore inexpensive enough for a rural population. This effort appears to be well targeted to receptive markets. The community participation approach is well suited to building household commitment to use the stoves effectively once in place. This kind of experience and commitment to stove dissemination deserves full support and the Government should carefully monitor its results for possible duplication.

4.37 **Institutional and Commercial Stoves**. Several international NGOs have worked in Uganda on improved institutional stoves. The most noteworthy effort was through the Bellerive Foundation (Aga Khan Foundation), using their Kenyan-developed institutional brick and cement stove design with molded, fitted pots. Bellerive alone helped install over 20 institutional stoves in schools in and around Kampala. A recent Forest Department survey indicated that at least 100 schools and hospitals have installed energy efficient institutional stoves since 1991.[28] As fuel comprises as much as 10 percent of these institutions' recurrent budget expenditures, this is not surprising.

4.38 Tests carried out by Bellerive on their Ugandan program, and results from similar activities in Kenya and Tanzania, showed reductions of wood fuel use on the

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[27] A pilot Household Energy survey was carried out during the Energy Assessment Mission of February 1994 to provide indicative estimates of fuel use in urban and rural households in the Central and Eastern regions of Uganda (see Annex 4.3).

[28] Bellerive Foundation, "Proceedings from the Masinde Workshop", Ministry of Natural Resources, Forest Department estimates, Ministry of Education interviews.

order of 30-40 percent with the new stoves. Given this, and the large amount of wood fuel utilized by institutions, considerable savings could be achieved by promoting the dissemination of improved institutional stoves.

4.39 In the commercial sector, wood and charcoal are widely used in hotels, restaurants, breweries and bakeries. Improving the efficiency of the stoves used could result in significant savings. The estimated annual consumption of wood and charcoal in commercial establishments is summarized in Table 4.5 below.

Table 4.5: Estimated Commercial Woody Biomass Consumption in 1994

Comm. Establishments	Char ('000 GJ)	Char ('000 tons)	Wood ('000 GJ)	Wood ('000 tons)
Hotels, Rests. & Bars	2,989	100	2,874	192
Bakeries	0	0	465	31
Breweries	0	0	1,109	74
Sub-Total Commercial	2,989	100	4,448	297

4.40 **Future Course of Action to Improve Stoves.** It is estimated that the continued momentum of the existing stove improvement programs could lead to the replacement of 25 percent of old charcoal stoves. However, to raise the saturation level to as much as 50 percent, which would be comparable to the most successful stove dissemination efforts previously realized in eastern Africa, a much more concerted campaign focusing on support to stove makers, stove certification, and stimulating the adoption of efficient stoves, should be carried out. With respect to wood stoves, well targeted dissemination efforts in rural areas, similar to the Dutch program, should be able to reach 15 percent of wood-using rural homes over a 15 year period. Households cooking with improved stoves may be assumed to achieve 45 percent wood-use reductions and 35 percent charcoal-use reductions. Assuming that the improved charcoal stove cost about USh 7,500 more than a Sigiri, and the improved wood stoves USh 5,000, the potential economic returns of successful dissemination projects could be very high (Annex 4.4).

4.41 A recent review of the experience of over 50 stove programs around the world indicates that in addition to a rapid payback period, which appears to be necessary for successful dissemination of stoves, successful efforts are those that maintain consistent, long-term, and high level commitment to stove manufacture and dissemination, and pay attention to targeting markets, and design stoves that consumers

actually want.[29] It is important to continue research and development of improved stove designs by having stove producers work closely with stove users.[30] Emphasis must be placed on flexibility of design, customer feedback, and service. Moreover, projects must include training of manufacturers in business operations and practices -- projecting the number of units to be sold, the number of units and parts to be produced and inventoried, and estimating needed production capacity. Certification and demonstration activities such as stove fairs and cooking competitions at community events have proved to be effective at convincing people to adopt improved stoves in other Eastern African countries.

4.42 Given the limited success of NGOs in disseminating improved stoves, the Government has an important role to play in reviewing, evaluating and coordinating improved stove activities, while leaving the actual supply of stoves to private enterprise. Government can serve as a:

- testing agency for technologies to gauge their actual performance;
- promoter an certifier of the technologies which actually save energy and which are acceptable and beneficial to consumers;
- promoter of technical assistance to stove producers to improve and maintain quality; and
- coordinator, monitor and evaluator to track developments in the market and facilitate the rapid dissemination of the best energy saving technologies and techniques.

4.43 **Industrial End-Use Efficiency**. The industrial biomass consumption in Uganda is higher than in any other country in the region. Limited availability and high prices of petroleum and electricity have stimulated biomass demand. Presently, in final energy terms, Ugandan industry consumes twice as much biomass energy (in GJ) as petroleum products, and over five times as much as electricity. Uganda's commercial sector consumes twenty times as much biomass as all other forms of energy combined (also in final energy terms).

4.44 Key industries which rely primarily and sometimes exclusively on biomass include tea production; construction industry including brick, tile and lime; tobacco curing; sugar refining/jaggeries; and fish smoking.

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29 Barnes Douglas, Keith Openshaw, Kirk Smith, and Robert van der Plas, "What Makes People Cook with Improved Stoves", FPD Energy Series Working Paper #60, the World Bank, 1993.

30 Stove makers are the key players on the supply side of any successful dissemination effort. Programs that involve stove producers early in the design process and employ standardized parts that can be easily produced stand a better chance of succeeding than those that do not pay attention to the production process. Designs that incorporate manufactured components such as pre-fabricated ceramic liners not only allow better quality control, but also last longer and require less maintenance than hand-made stoves.

4.45 Uganda's **tea production** has doubled over the past three years as more areas are rehabilitated and new areas are planted. The tea industry has converted almost entirely to wood; the twelve of the country's thirteen major tea factories consume over 30,000 tons of fuel wood for drying, fermenting and power. Wood consumption will continue to increase as more expansion occurs. These factories are extending their own tree plantations to meet demand, although they still buy considerable quantities.

4.46 The **construction industry** has grown at an average rate of over 7 percent since 1990.[31] Brick and tile production have doubled over the past six years and accounted for 230,000 tons of wood consumption in 1994. Extensive deposits of limestone and growing demand in the construction industry have led to an annual average increase in lime production of 29 percent since 1989. Most lime is produced by small- to medium-scale enterprises, using energy-inefficient lime kilns. An average of two kilograms of wood are used per kilogram of lime produced. This makes lime production the main consumer of wood, accounting for nearly 650,000 tons of wood in 1994. While studies have been conducted on improving efficiency, particularly in the brick and tile industry, little has been done. Considerable scope exists for improving production techniques and efficiency of end-use. As with charcoalers, the starting point for improving end-use efficiency in this sub-sector will be in promoting the organization of producers, so they can be reached more easily with new ideas and methods.

4.47 Over sixteen thousand rural Ugandans use fuel wood to cure **tobacco** in over 9,600 barns. Approximately half of these farmers use the energy-inefficient "flue" curing method. Approximately 2,500 farmers have converted to more energy-efficient barns since 1989. Considerable scope exists for reducing unit energy consumption. and consequently, British American Tobacco (BAT), Uganda's largest tobacco agent, has begun to promote tree planting among tobacco farmers, following BAT's lead in Kenya and Malawi.

4.48 The two major **sugar refineries** currently utilize small amounts of wood to raise boiler temperatures to burn bagasse. In addition, at least 39 smaller-scale sugar "jaggeries", which produce between 15-20 percent of the sugar consumed in Uganda, utilize large quantities of wood. "Jaggery" is produced primarily over open fires and occasionally with old boilers. Energy efficiencies are very low. This industry consumers nearly 100,000 tons of wood annually. The sugar refining industry provides a good example of what can be done to improve the efficiency of energy use. In 1994, the Lugari Sugar Estate, where bagasse currently provides 90 percent of energy, embarked upon an energy efficiency program to reduce the moisture content of bagasse. As a result, the efficiency of bagasse use has increased by over 10 percent (by reducing the moisture content from 50% to approximately 15%). A similar approach has been taken at Kakira Sugar, where power generated from bagasse currently meets 60 percent of its total power

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[31] Mining, of which lime is the major economic component, has grown by over 9% per annum since 1991 (see "Background to the Budget", various years, Statistics Dept., MFEP).

needs. Larger sugar refineries could achieve similar recovery rates on bagasse through better management and a more efficient bagasse drying methods.

4.49 **Fish** is Uganda's major protein staple. An estimated 40 percent of all fish is smoked mainly over open and sometimes enclosed fires.[32] An estimated 130,000 tons of wood is consumed. Major efficiency improvements have been made in other countries in similar circumstances and with similar fish demand (e.g., Malawi, Tanzania, Zimbabwe). In Uganda, however, production will need to be first organized and rationalized before major efficiency improvements can be made.

4.50 The estimated biomass consumption in industries is summarized in Table 4.5.

Table 4.5. Wood Consumption in Ugandan Industries in 1994 ('thousands tons and in TJ)

Industry	Tons ('000s)	('000 GJ)	% Total
Lime	646	9,696	54.7%
Bricks & Tiles	230	3,443	19.4%
Fish	134	2,004	11.3%
Sugar/Jaggeries	95	1,426	8.0%
Tobacco	63	938	5.3%
Tea	31	210	1.2%
Sub-Total Industry	1,198	17,717	100.0%

Source: Forest Department, Ministry of Finance and Economic Planning (various publications), Uganda Lime Producers Association, NORAD, World Bank/UNDP ESMAP studies, British American Tobacco (BAT), Uganda Tea Growers Corporation, Fisheries Department, ESD field interviews and surveys.

4.51 Government and donors can accelerate efficiency improvements in industries through promoting such mechanisms as provision of investment credit (e.g., for retrofitting boilers), technical assistance and training in demand-side management and fuel switching, and energy audits to indicate where improvements can be made. The private sector should be encouraged to provide energy audits and other energy services to industries.

[32] Source: Fisheries Department. Earlier estimates made by the Team indicated 70% of all fish caught was smoked. Later information from experts in the field show that the earlier estimate was probably true several years ago. Now, however, with improved transport and handling facilities (including refrigeration), probably no more than 40% of all fish is smoked. Wood consumption figures have been revised accordingly.

F. BIOGAS PROGRAM

4.52 The Ugandan Government has undertaken two biogas programmes since the early-1980s. A third programme was initiated through the Church of Uganda in the early-1980s. The latest biogas programme under the GOU/IDA Power II and III Projects is now coming to a close. Both the initial and current programmes have been expensive, and have not demonstrated any economic viability, particularly for units installed in households.

4.53 While a potentially interesting energy option, the viability of biogas needs to be carefully examined. For instance, biogas can only realistically be targeted towards institutional (e.g., schools and hospitals) and commercial consumers, given the high capital costs and maintenance requirements. However, these institutions rarely meet the requirements for biogas digestion, unless they are dairies or abattoirs. Among the requirements for sustainable biogas digester operation are an adequate year-round supply of water, a system of stall-feeding of cattle which enables dung to be easily collected, a suitable temperature regime (above 20 C), and the willingness of the owners to carry out the substantial cleaning and management of the digester. For many institutions, purchasing wood, instead, may be both a more inexpensive and manageable task, requiring little, if any, capital investment.

4.54 Given these factors, biogas remains an expensive energy option. Its applications will remain experimental so long as less expensive fuel wood is available. Since there is no clear demand from consumers for biogas, and as it is clear that small and medium sized biogas applications will not be able to compete financially in the marketplace against wood and electricity, the Government should not extend its biogas program.

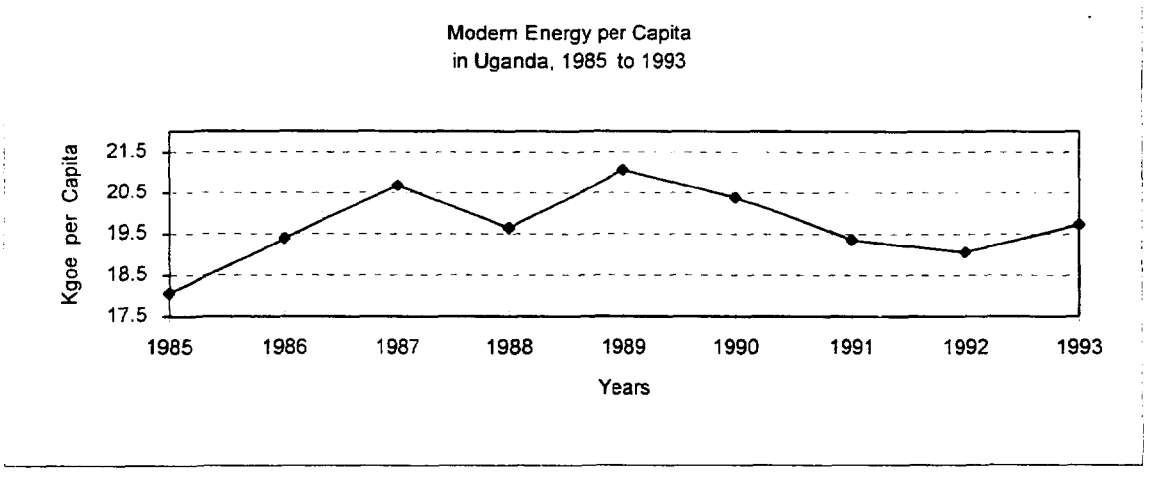
Uganda Energy Balance, 1990 (mtoe)

	Fuelwood	Charcoal	Crop Residues (incl Bagasse)	Coffee hulls	Gasoline	Aviation Turb fuel	Kerosene	Diesel (automotive)	Heavy Fuel Oil	LPG	Hydro	Electricity	Total
Indigenous Production	5023	0	686	7	0	0	0	0	0	0	188	0	5904
Flare and Loss	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Injection	0	0	0	0	0	0	0	0	0	0	0	0	0
Imports	0	0	0	0	92	14	35	88	13	0	0	0	242
Exports	0	0	0	0	0	0	0	0	0	0	0	-17	-17
Bunkers	0	0	0	0	0	0	0	0	0	0	0	0	0
Stock Change	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Supply 1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Supply 2	0	0	0	0	0	0	0	0	0	0	0	0	0
Primary Energy Supply	**5023**	**0**	**686**	**7**	**92**	**14**	**35**	**88**	**13**	**0**	**188**	**-17**	**6129**
% All Primary Energy	82.0%	0.0%	11.2%	0.1%	1.5%	0.2%	0.6%	1.4%	0.2%	0.0%	3.1%	-0.3%	100.0%
Charcoal Production	-815	228	0	0	0	0	0	0	0	0	0	0	-587
Petroleum Refining	0	0	0	0	0	0	0	0	0	0	0	0	0
Gas Manufacture	0	0	0	0	0	0	0	0	0	0	0	0	0
Power Generation													
Useful Energy	0	0	0	0	0	0	0	0	0	0	-63	63	0
Losses	0	0	0	0	0	0	0	0	0	0	-124	0	-124
Trans and Dist Losses	0	0	0	0	0	0	0	0	0	0	0	-19	-19
Own Use / Losses	-214	-12	-172	-2	0	0	0	0	0	0	0	0	-399
Other Conversion 1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Conversion 2	0	0	0	0	0	0	0	0	0	0	0	0	0
Net Supply Available	**3995**	**216**	**514**	**5**	**92**	**14**	**35**	**88**	**13**	**0**	**0**	**27**	**5000**
% Net Supply Available	79.9%	4.3%	10.3%	0.1%	1.8%	0.3%	0.7%	1.8%	0.3%	0.0%	0.0%	0.5%	100.0%
Residential/Commercial	3247	216	482	0	0	0	35	0	0	0	0	16	3996
Industry	732	0	33	5	0	0	0	1	13	0	0	4	787
Transport	0	0	0	0	92	14	0	87	0	0	0	0	193
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Consumption	16	0	0	0	0	0	0	0	0	0	0	7	24
Non-Energy Use	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Consumption 1	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Consumption 2	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Consumption	**3995**	**216**	**514**	**5**	**92**	**14**	**35**	**88**	**13**	**0**	**0**	**27**	**5000**
Stat. Diff.	0	0	0	0	0	0	0	0	0	0	0	0	0
% All Secondary Energy	79.9%	4.3%	10.3%	0.1%	1.8%	0.3%	0.7%	1.8%	0.3%	0.0%	0.0%	0.5%	100.0%

Consumption of Modern Energy, 1983 to 1993
UGANDA

	Pet Product mill litres	Electricity GWh	Total Modern Energy 000 TOE	Oil Intensity Kgoe of Oil / US$000 GDP	Elect Intensity Kgoe of Oil / US$000 GDP	Energy Intensity Kgoe per US$000 GDP	Energy/Capita Kgoe per Capita
1983	216.0	251.1	240	na	na	na	17.35
1984	223.2	281.8	253	na	na	na	18.04
1985	240.7	244.1	258	92.8	28.7	121.4	18.07
1986	256.1	299.1	285	98.1	34.9	133.0	19.39
1987	277.4	338.1	312	99.5	37.0	136.5	20.67
1988	291.3	262.7	305	97.2	26.7	123.9	19.64
1989	325.2	275.7	336	101.1	26.1	127.2	21.06
1990	296.2	363.0	334	88.5	33.1	121.5	20.38
1991	267.7	425.0	326	76.8	37.2	114.0	19.37
1992	253.7	486.0	330	70.5	41.2	111.7	19.07
1993	280.7	480.0	350	74.3	38.7	113.0	19.72
AAG 1983/1993	2.7%	6.7%	3.9%				
AAG 1987/1993	0.2%	6.0%	1.9%				

Note: Electricity converted to 000 TOE at .25XGwh, and average coversion for petroleum products is 0.82Xmill litres litres 1992 dollars for GDP.
Source: Compiled by Mission.



ENERGY DEMAND PROJECTIONS

1. Economic growth and population growth in urban and rural areas are the main driving forces in energy demand. The demand for each type of energy is projected and then aggregated to obtain a projection of all energy demand: modern and traditional. Even at the apparently high rates of growth of demand for energy (6.9% and 8.7%), Uganda's consumption and the energy intensity of its economy will remain well below those of neighboring Kenya.

2. The government's target for GDP growth is between 5% and 6% per year a reasonable target for the medium term. The agricultural sector contributes some 50% to GDP so that its long term growth is critical to achieving a sustained and high GDP growth rate. On the other hand, the leading sectors for high economic growth are light industry and agro-industry, related to rapid increases in exports. The Base Case forecasts industrial growth of 9.5%, followed by trade/other at 6.5% to 7% per year, along with a solid and sustained performance of 4.5% per year from the agricultural sector. The overall GDP growth rate is 5.9% per year. The High Case has overall GDP growth of 7% per year.

Table 1: Forecast Growth Rates of GDP, by Sector, in Uganda

	Base Case			High Case		
	1990-93	1994-96	1997-2010	1990-93	1994-96	1997-2010
Agriculture	4.0%	4.5%	4.5%	4.0%	5.0%	5.0%
Construction	5.5%	6.0%	5.5%	5.5%	8.5%	8.0%
Industry	7.0%	9.5%	9.5%	7.0%	12.5%	12.6%
Trade/Other	5.5%	6.5%	7.0%	5.5%	8.5%	8.0%
Total GDP	4.8%	5.3%	6.0%	4.8%	6.1%	7.2%
Avg. GDP over 1994-2010			5.9%			7.0%

Source: Mission Estimates.

3. In the base case, the rate of growth of gasoline was tied to total GDP with an elasticity of 1.20 up to 1996 and 1.10 over the period 1996-2012. The diesel growth rate was tied to Trade/Other GDP (includes transportation) with an elasticity of 1.30 and 1.20 respectively. Aviation fuel sales in 1993 were more than double, due to a supply problem in Kenya during the first half of the year. Consequently, it was assumed that 1994 sales would be only 25,000M3 which was then used as the base year for projecting aviation fuel demand. The growth rates of aviation fuel, fuel oil and LPG were tied to Industry GDP while the kerosene growth rate was tied to rural population growth (see also Annex 2.5).

4. As mentioned, the energy intensity in GDP is low. The Base Case projection gives a resultant overall elasticity of modern energy (primary energy) with respect the GDP of 1.1. Modern energy intensity increases from 160kg per $000 GDP in 1994 to 170 kg per $000 GDP by the year 2005. In 1994, some 52% of modern energy is supplied through petroleum products and about 48% through hydro electricity generation.

Uganda Forecast 15/5/95

BASE CASE MODERN ENERGY CONSUMPTION FORECAST

	Petroleum Products		Natural Gas				Forecast %			
	Transport+ Ind etc	Elect	Industry etc	Elect	Coal	Electricity Gen load	Gen Load is Hydro or Other Primary	Total Modern Energy	Modern Energy/GDP Kgoe/	Modern Energy/Capita Kgoe/
	mill litres	mill litres	bcf	bcf	000 tons	GWh	Electricity	000 TOE	$000 GDP	Capita
1990	302.7	0.0	0.0	0.0	0.0	735.7	99.50%	450	164	27
1991	282.1	0.0	0.0	0.0	0.0	781.0	99.50%	443	154	26
1992	274.2	0.0	0.0	0.0	0.0	993.1	99.50%	489	162	28
1993	308.4	0.0	0.0	0.0	0.0	971.2	99.50%	514	162	29
1994	315.4	0.0	0.0	0.0	0.0	1030.9	99.50%	535	160	29
1995	336.6	0.0	0.0	0.0	0.0	1082.8	99.50%	566	161	30
1996	359.2	0.0	0.0	0.0	0.0	1138.8	99.50%	600	161	31
1997	383.4	0.0	0.0	0.0	0.0	1187.7	99.50%	634	161	32
1998	409.3	0.0	0.0	0.0	0.0	1252.9	99.50%	673	161	33
1999	437.0	0.0	0.0	0.0	0.0	1323.3	99.50%	715	162	34
2000	466.8	0.0	0.0	0.0	0.0	1399.3	99.50%	760	163	35
2001	498.7	0.0	0.0	0.0	0.0	1496.8	99.50%	812	164	37
2002	533.0	0.0	0.0	0.0	0.0	1603.1	99.50%	869	166	38
2003	569.7	0.0	0.0	0.0	0.0	1719.1	99.50%	930	168	40
2004	609.1	0.0	0.0	0.0	0.0	1845.7	99.50%	996	169	41
2005	651.4	0.0	0.0	0.0	0.0	1983.8	99.50%	1068	171	43
2006	696.7	0.0	0.0	0.0	0.0	2134.7	99.50%	1146	173	45
2007	745.4	0.0	0.0	0.0	0.0	2299.4	99.50%	1229	176	47
2008	797.7	0.0	0.0	0.0	0.0	2479.3	99.50%	1320	178	49
2009	853.8	0.0	0.0	0.0	0.0	2675.9	99.50%	1419	180	51
2010	914.0	0.0	0.0	0.0	0.0	2890.7	99.50%	1525	182	54
2011	978.7	0.0	0.0	0.0	0.0	3125.6	99.50%	1641	185	56
2012	1048.1	0.0	0.0	0.0	0.0	3382.4	99.50%	1766	188	59
AAG 1990-1995		2.1%				8.0%		4.7%		
1996-2005		6.8%				6.2%		6.6%		
1990-2005		5.2%				6.8%		5.9%		
20 year; 1992-2012		6.9%				6.3%		6.6%		

Factors to convert to 000 TOE

mill litres tim	0.882	Petroleum Products
bcf times	24.7	Natural Gas
000tons tim	0.62745	Coal
GWh times	0.25	Electricity (times primary percentage)

Uganda Forecast 15/5/95

HIGH CASE MODERN ENERGY CONSUMPTION FORECAST

	Petroleum Products		Natural Gas				Forecast %			
	Transport+		Industry			Electricity	Gen Load is	Total	Modern	Modern
	Ind etc	Elect	etc	Elect	Coal	Gen load	Hydro or	Modern	Energy/GDP	Energy/Capita
	mill litres	mill litres	bcf	bcf	000 tons	GWh	other primary	Energy	Kgoe/	Kgoe/
							Electricity	000 TOE	$000 GDP	Capita
1990	302.7	0.0	0.0	0.0	0.0	735.7	11.82%	273	99	17
1991	282.1	0.0	0.0	0.0	0.0	781.0	11.40%	256	89	15
1992	274.2	0.0	0.0	0.0	0.0	993.1	11.20%	255	85	15
1993	308.4	0.0	0.0	0.0	0.0	971.2	11.00%	283	89	16
1994	319.4	0.0	0.0	0.0	0.0	1039.7	11.00%	294	87	16
1995	346.1	0.0	0.0	0.0	0.0	1102.2	10.50%	316	87	17
1996	375.1	0.0	0.0	0.0	0.0	1170.7	10.50%	342	88	18
1997	405.6	0.0	0.0	0.0	0.0	1232.2	10.00%	367	89	18
1998	438.7	0.0	0.0	0.0	0.0	1313.0	10.00%	397	90	19
1999	474.6	0.0	0.0	0.0	0.0	1401.9	9.50%	427	91	20
2000	513.7	0.0	0.0	0.0	0.0	1499.7	9.50%	462	92	21
2001	556.2	0.0	0.0	0.0	0.0	1624.6	9.00%	498	92	22
2002	602.4	0.0	0.0	0.0	0.0	1763.7	9.00%	540	93	24
2003	652.7	0.0	0.0	0.0	0.0	1918.7	8.50%	582	94	25
2004	707.3	0.0	0.0	0.0	0.0	2091.7	8.50%	632	95	26
2005	766.8	0.0	0.0	0.0	0.0	2284.8	8.00%	682	96	28
2006	831.5	0.0	0.0	0.0	0.0	2500.8	8.00%	740	97	29
2007	901.9	0.0	0.0	0.0	0.0	2742.4	8.00%	803	98	31
2008	978.5	0.0	0.0	0.0	0.0	3013.1	8.00%	872	99	32
2009	1061.9	0.0	0.0	0.0	0.0	3316.5	8.00%	948	101	34
2010	1152.7	0.0	0.0	0.0	0.0	3657.1	8.00%	1030	102	36
2011	1251.5	0.0	0.0	0.0	0.0	4039.7	8.00%	1120	103	38
2012	1359.1	0.0	0.0	0.0	0.0	4469.9	8.00%	1217	104	41
	2.7%					8.4%		3.0%		
	8.3%					7.6%		8.0%		
	6.4%					7.8%		6.3%		
	8.3%					7.8%		8.1%		

Factors to convert to 000 TOE

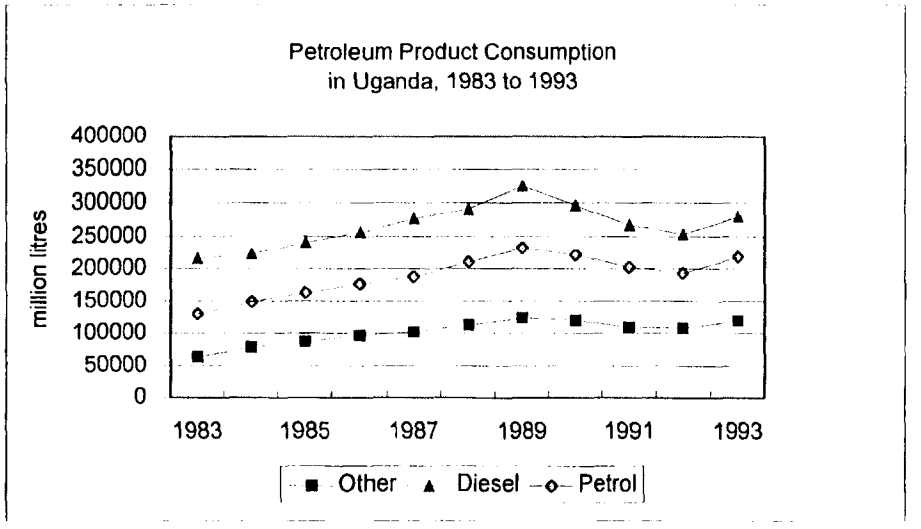
mill litres tim	0.83	Petroleum Products
bcf times	24.7	Natural Gas
000tons tim	0.62745	Coal
GWh times	0.25	Electricity (times primary percentage)

CONSUMPTION OF PETROLEUM PRODUCTS

(000 litres), 1983 to 1993

	Petrol	Kero	Av Fuel	Diesel	Fuel Oil	LPG	TOTAL
1983	63359	39100	22300	67100	23600	500	215959
1984	78166	39100	19000	71000	15400	500	223166
1985	87461	43600	21700	75700	11700	500	240661
1986	96381	43189	22736	79959	13357	508	256130
1987	101540	41022	30000	85818	18200	850	277430
1988	112566	43544	21653	97464	15310	779	291316
1989	123673	47220	31946	108672	13156	562	325229
1990	120408	42360	16796	101271	14868	488	296191
1991	109512	34562	17546	92672	12809	567	267668
1992	107752	29409	17721	85108	13039	632	253661
1993	120000	30000	18000	98000	14000	700	280700
AAG 1983/1993	6.6%	-2.6%	-2.1%	3.9%	-5.1%	3.4%	2.7%

Source: Statistics Department, Ministry of Finance and Planning, Uganda



ECONOMIC AND OTHER PARAMTERS FOR FORECASTING

	GDP Growth Rates						GDP Elast		Long-Run Price
	1990-93	1994-96	1997-2012	Average	Link from	Link to	1991-96	1997-2012	Elast
Agriculture	4.0%	4.5%	4.5%						
Constr	5.5%	6.0%	5.5%						
Industry	7.0%	9.5%	9.5%		ind GDP	AF/O	1.00	1.00	0.60
Trade/other	5.5%	6.5%	7.0%		Trade/o GDP	Diesel	1.30	1.20	0.70
Total GDP	4.8%	5.3%	6.0%	5.9%	total GDP	Petrol	1.20	1.10	0.80
					ind GDP	FUEL OIL	0.80	0.70	0.60
					ind GDP	LPG	1.20	1.00	0.70
Electricity Gen Growth					elect gen	Electricity Use	0.00	0.00	
	Population Growth Rates						Pop Elast		
Urban	6.5%	6.5%	6.5%						
Rural	2.2%	2.4%	2.0%		Rural Pop	Kerosene	1.10	1.00	0.60
Total	2.7%	2.9%	2.8%						

	Trans+Ind+Agr etc		For Elect Gen					AV			ANNUAL GROWTH
	DIESEL	FUEL OIL	DIESEL	FUEL OIL	PETROL	KEROSENE	LPG	FUELS	OTHER	TOTAL	%/YR
1990	103.3	14.9	0.0	0.0	123.4	43.4	0.9	16.8	0.0	302.7	
1991	96.7	12.8	0.0	0.0	117.5	36.6	1.0	17.5	0.0	282.1	-6.8%
1992	90.1	13.0	0.0	0.0	119.8	32.4	1.2	17.7	0.0	274.2	-2.8%
1993	91.2	15.7	0.0	0.0	131.6	32.5	1.2	36.2	0.0	308.4	12.5%
1994	98.9	16.9	0.0	0.0	139.9	33.3	1.3	25.0	0.0	315.4	2.3%
1995	107.3	18.2	0.0	0.0	148.8	34.2	1.5	26.6	0.0	336.6	6.7%
1996	116.3	19.6	0.0	0.0	158.2	35.1	1.7	28.4	0.0	359.2	6.7%
1997	126.1	20.9	0.0	0.0	168.6	35.8	1.8	30.2	0.0	383.4	6.7%
1998	136.7	22.2	0.0	0.0	179.7	36.5	2.0	32.2	0.0	409.3	6.8%
1999	148.2	23.7	0.0	0.0	191.4	37.2	2.2	34.3	0.0	437.0	6.8%
2000	160.6	25.3	0.0	0.0	204.0	38.0	2.4	36.5	0.0	466.8	6.8%
2001	174.1	27.0	0.0	0.0	217.4	38.7	2.6	38.9	0.0	498.7	6.8%
2002	188.7	28.8	0.0	0.0	231.6	39.5	2.9	41.5	0.0	533.0	6.9%
2003	204.6	30.7	0.0	0.0	246.8	40.3	3.1	44.2	0.0	569.7	6.9%
2004	221.8	32.7	0.0	0.0	263.0	41.0	3.4	47.1	0.0	609.1	6.9%
2005	240.4	34.9	0.0	0.0	280.3	41.9	3.8	50.1	0.0	651.4	6.9%
2006	260.6	37.2	0.0	0.0	298.7	42.7	4.1	53.4	0.0	696.7	7.0%
2007	282.5	39.7	0.0	0.0	318.3	43.5	4.5	56.9	0.0	745.4	7.0%
2008	306.2	42.4	0.0	0.0	339.2	44.4	4.9	60.6	0.0	797.7	7.0%
2009	331.9	45.2	0.0	0.0	361.4	45.3	5.4	64.6	0.0	853.8	7.0%
2010	359.8	48.2	0.0	0.0	385.1	46.2	5.9	68.8	0.0	914.0	7.1%
2011	390.1	51.4	0.0	0.0	410.4	47.1	6.5	73.3	0.0	978.7	7.1%
2012	422.8	54.8	0.0	0.0	437.4	48.0	7.1	78.1	0.0	1048.1	7.1%
AAG 93-2005	8.4%	6.9%	0.0	0.0	6.5%	2.1%	10.0%	2.8%	0.0	6.4%	
AAG 93-2010	8.4%	6.8%	0.0	0.0	6.5%	2.1%	9.8%	3.8%	0.0	6.6%	

Note: It is assumed that relatively high prices remain for aviation fuels in Uganda.

HIGH CASE

PETROLEUM PRODUCT DEMAND FORECAST

Uganda Forecast 15/5/95

ECONOMIC AND OTHER PARAMTERS FOR FORECASTING

	GDP Growth Rates						GDP Elast		Long-Run Price Elast
	1990-93	1994-96	1997-2012	Average	Link from	Link to	1991-96	1997-2012	
Agriculture	4.0%	5.0%	5.0%						
Constr	5.5%	8.5%	8.0%						
Industry	7.0%	12.5%	12.6%		ind GDP	AF/O	1.00	1.00	0.60
Trade/other	5.5%	8.5%	8.0%		Trade/o GDP	Diesel	1.30	1.20	0.70
Total GDP	4.8%	6.1%	7.2%	7.0%	total GDP	PETROL	1.20	1.10	0.80
					ind GDP	FUEL OIL	0.80	0.70	0.60
					ind GDP	LPG	1.20	1.00	0.70
Electricity Gen Growth					elect gen	Electricity Use	0.00	0.00	
	Population Growth Rates						Pop Elast		
Urban	6.5%	6.5%	6.5%						
Rural	2.2%	2.4%	2.0%		Rural Pop	Kerosene	1.10	1.00	0.60
Total	2.7%	2.9%	2.8%						

	Trans+Ind+Agr etc		For Elect Gen					AV			ANNUAL GROWTH
	DIESEL	FUEL OIL	DIESEL	FUEL OIL	PETROL	KEROSENE	LPG	FUELS	OTHER	TOTAL	%/YR
1990	103.3	14.9	0.0	0.0	123.4	43.4	0.9	16.8	0.0	302.7	
1991	96.7	12.8	0.0	0.0	117.5	36.6	1.0	17.5	0.0	282.1	
1992	90.1	13.0	0.0	0.0	119.8	32.4	1.2	17.7	0.0	274.2	-2.8%
1993	91.2	15.7	0.0	0.0	131.6	32.5	1.2	36.2	0.0	308.4	12.5%
1994	101.3	17.3	0.0	0.0	141.2	33.3	1.4	25.0	0.0	319.4	3.6%
1995	112.5	19.0	0.0	0.0	151.4	34.2	1.6	27.4	0.0	346.1	8.3%
1996	124.9	20.9	0.0	0.0	162.5	35.1	1.8	29.9	0.0	375.1	8.4%
1997	136.9	22.7	0.0	0.0	175.3	35.8	2.1	32.8	0.0	405.6	8.1%
1998	150.0	24.7	0.0	0.0	189.1	36.5	2.3	35.9	0.0	438.7	8.2%
1999	164.4	26.9	0.0	0.0	204.0	37.2	2.6	39.4	0.0	474.6	8.2%
2000	180.2	29.3	0.0	0.0	220.2	38.0	2.9	43.1	0.0	513.7	8.2%
2001	197.5	31.9	0.0	0.0	237.5	38.7	3.3	47.2	0.0	556.2	8.3%
2002	216.5	34.7	0.0	0.0	256.3	39.5	3.7	51.8	0.0	602.4	8.3%
2003	237.3	37.8	0.0	0.0	276.5	40.3	4.2	56.7	0.0	652.7	8.3%
2004	260.0	41.1	0.0	0.0	298.3	41.0	4.7	62.1	0.0	707.3	8.4%
2005	285.0	44.7	0.0	0.0	321.9	41.9	5.3	68.0	0.0	766.8	8.4%
2006	312.4	48.7	0.0	0.0	347.3	42.7	6.0	74.5	0.0	831.5	8.4%
2007	342.3	53.0	0.0	0.0	374.7	43.5	6.7	81.7	0.0	901.9	8.5%
2008	375.2	57.6	0.0	0.0	404.3	44.4	7.6	89.4	0.0	978.5	8.5%
2009	411.2	62.7	0.0	0.0	436.2	45.3	8.5	98.0	0.0	1061.9	8.5%
2010	450.7	68.2	0.0	0.0	470.6	46.2	9.6	107.3	0.0	1152.7	8.5%
2011	494.0	74.3	0.0	0.0	507.8	47.1	10.8	117.6	0.0	1251.5	8.6%
2012	541.4	80.8	0.0	0.0	547.9	48.0	12.2	128.8	0.0	1359.1	8.6%
AAG 93-2005	10.0%	9.1%	0.0	0.0	7.7%	2.1%	13.2%	5.4%	0.0	7.9%	
AAG 93-2010	9.9%	9.0%	0.0	0.0	7.8%	2.1%	13.0%	6.6%	0.0	8.1%	
								OVERALL GDP Elasticity		1.15	

Note: It is assumed that relatively high prices remain for aviation fuels in Uganda.

Annex 2.3

COMPARISON OF CARGO-SIZE FREIGHT VS. COST OF WORKING CAPITAL

Assumptions:

1. Part-cargo parcel size is 8000 MT.
2. Full cargo size is 25,000 MT.
3. Current LIBOR (London Interbank Offered Rate) interest is 4.3125%.
4. Average freight cost difference of one-port vs. two-port discharge is US$ 3.00/MT.
5. Average current clean product CIF cost is US$ 165/m^3.
6. Clean product demand is 320 m^3/day from Tanzania and 480 m^3/day from Kenya.

Cargo Freight Savings
US$ 3.00/MT = US$ 2.36/m^3 or 0.24 US cents/liter
1.27 m^3/MT

Cost of Working Capital, ex-Tanzania
a. 8000MT x 1.27 m^3/MT = 10,160m^3; 10,160m^3/320 m^3/day = 32 days
165 US$/$m^3$ x 4.3125% x 32 days/365 days = US$ 0.62/m^3 or = 0.06 US cents/liter

b. 25,000MT x 1.27m^3/MT = 31,750m^3; 31,750m^3/320m^3/day = 99 days
(165-2.36) US$/$m^3$ x 4.3125% x 99 days/365 days = US$ 1.90/m^3 or = 0.19 US cents/liter

Large cargo more costly by 0.19 - 0.06 = 0.13 US cents/liter

Cost of Working Capital, ex-Kenya
a. 8000MT x 1.27 m^3/MT = 10,160m^3; 10,160m^3/480 m^3/day = 21 days
165 US$/$m^3$ x 4.3125% x 21 days/365 days = US$ 0.41/m^3 or = 0.04 US cents/liter

b. 25,000MT x 1.27m^3/MT = 31,750m^3; 31,750m^3/480m^3/day = 66 days
(165-2.36) US$/$m^3$ x 4.3125% x 66 days/365 days = US$ 1.27/m^3 or = 0.13 US cents/liter

Large cargo more costly by 0.13 - 0.04 = 0.09 US cents/liter

Conclusion
a. There is an incentive of (0.24 - 0.13) = 0.11 US cents/liter to use fully loaded General Purpose vessels (20,000-25,000MT) when replenishing terminals in Dar es Salaam.

b. There is an incentive of (0.24 - 0.09) = 0.15 US cents/liter to use fully loaded General Purpose vessels when replenishing terminals in Mombasa.

Source: Mission developed.

PHYSICAL DATA ON THE KENYA PIPELINE COMPANY (KPC)

1. Mombasa
   -KPC terminal with 70,000 m^3 of storage for clean products.
   -(All marketing companies have large terminals that have access to the KPC Pipeline via the Mombasa Refinery.)

2. KPC Pipeline (Mombasa to Nairobi)
   -14 inch pipeline, currently pumping 5-6000 m^3 per day.
   -Has pumped as high as 8600 m^3 per day.
   -Has "rated" capacity of 10,000 m^3 per day.
   -Could double capacity with addition of one pumping station.

3. Nairobi
   -KPC terminal has 100,000 m^3 of clean products storage.
   -(Marketing companies have 24,000 m^3 of storage to receive direct from the pipeline.)

4. KPC Pipelines (Nairobi to Eldoret and Kisumu)
   -One 8 inch pipeline that splits into two 6 inch pipelines, one to Eldoret and one to Kisumu.
   -Capacity from Nairobi is 5000 m^3 per day.
   -Potential capacity for the export market is 2200-2500 m^3 per day. Remaining capacity is reserved for the western Kenya market. Current need for Uganda is 550 m^3/day, assuming 30% of the total demand is supplied from Dar. Most of the requirements of Rwanda and eastern Zaire would also be moved through the pipeline to Eldoret (probably amounts to 500 m^3/day).

5. Eldoret
   -KPC terminal has 40,000 m^3 of clean products storage.
   -(Marketing companies have 3700 m^3 of total storage.)

6. Kisumu
   -KPC terminal has 40,000 m^3 of clean products storage.
   -(Marketing companies have 5000 m^3 of total storage.)

Source: Ministry of Natural Resources.

TOTAL PETROLEUM PRODUCT STORAGE IN UGANDA, M^3

Location	Petrol	Kerosene	Diesel	Fuel Oil	Turbo Fuel	LPG
Kampala	5748	1978	5401	615	-	117
Entebbe	-	-	-	-	2500	-
Jinja					-	-
--Oil Companies	1826	406	918	605	-	-
--MNR	10000	10000	10000	-		
Mbale	1336	258	798	250		
Kasese	595	164	1322	857	-	-
Totals	19505	12806	18439	2327	2500	117
1993 Demand m^3/day	361	89	250	43	99	3
Days Supply	54	144	74	54	25	39
Days Supply, Without MNR	26	32	34	54	25	39

Source: Ugandan Oil Companies

PETROLEUM PRICE MONITORING SYSTEM

Main Issues

1. In order to be satisfied that competitive forces are active in the Uganda petroleum product marketplace, it will be necessary to implement a monitoring system. The main issues will be:

a. Establish an accurate price build-up for CIF Kampala price comparisons to check offshore price differences.

b. Initiate an on-going pump price monitoring system to check whether competition or collusion is at work.

CIF Kampala Price Monitoring

2. Two of the items that need to be checked , namely the FOB and the ocean freight, currently cannot be verified because this information has not been purchased by the Government of Uganda. The Petroleum Commissioner, who is responsible for the price build-up, needs Platt's quotations in the Mediterranean and the Arabian Gulf for three products. Rather than subscribe to Platt's Oilgram, which is very expensive, Platt's offers a weekly summary of just those items that are needed and this service is quite reasonable (US$ 500-700 per year). It is recommended that the MNR make funds available to purchase this weekly summary from Platt's.

3. For monitoring purposes, the following FOB quotations from Platt's Oilgram weekly summary should be used:

- Petrol: Since there is no quotation for premium petrol in the Arabian Gulf, the high quotation for Prem 0.15 from "Cargoes FOB Med Basis Italy" should be used. This quotation is given in US dollars per metric ton. The high quote is used to reflect a small add-on by the traders to cover their communications costs with their buyers when lining up specific ships, shipping dates and cargo layouts.

- Kerosene: The high quotation for Kero from "FOB Arab Gulf" (in US dollars per barrel) is multiplied by 7.9 and averaged with the high quotation for Jet from "Cargoes FOB Med Basis Italy".

- Diesel: The high quotation for Gas Oil from "FOB Arab Gulf" (in US dollars per barrel) is multiplied by 7.4 and averaged with he high quotation for Gas Oil from "Cargoes FOB Med Basis Italy".

A monthly average quotation for each product should then be developed. Because of the delay in products reaching Uganda from the time they are purchased, the previous two-month average quotations should be averaged and used for comparative purposes for the entire month.

4. In order to determine the ocean freight to be used in the price build-up, it is necessary to have Worldscale flat rates for some basic voyages and the current AFRA adjustment for clean 25,000 MT vessels (MR class). It is suggested that the Worldscale flat rates for Yanbu/Mombasa, Kuwait/Mombasa and Bahrain/Mombasa be averaged and used with the current AFRA adjustment for the ocean freight for Kenya-sourced products in the price build-up. Likewise, the Worldscale flat rates for Yanbu/Dar es Salaam, Kuwait/Dar es Salaam and Bahrain/Dar es Salaam should be averaged and used with the current AFRA adjustment for the ocean freight for the Tanzania-sourced products in the price build-up. This is done for the current Worldscale flat rates and shown in Table1.

Table 1: WORLDSCALE Flat Rates, US$/MT

Loading Port	Kenya-Source	Tanzania-Source
Yanbu	4.44	4.60
Kuwait	5.92	6.07
Bahrain	5.44	5.59
Average Flat Rate	5.27	5.42

Source: Mission developed from Worldscale.

5. Worldscale flat rates are revised every six months and AFRA adjustments, by class of vessel, are published every month. The AFRA adjustment, which reflects the current shipping market for each class of vessel, is multiplied by the Worldscale flat rate to arrive at the freight rate for that particular voyage. It must be realized that the oil companies are importing their products by two port discharges which would add another US$1.00-2.00/MT to their freight costs. Worldscale and AFRA can be subscribed to from the following address:

Worldscale (London) Ltd.
Prince Rupert House
64 Queen Street
London, EC4R-1AD
Telephone: 44 71 248 4747

The cost for Worldscale amounts to 875 pounds sterling/year. The cost for AFRA amounts to US$ 3600/year. These subscriptions are rather expensive, but if the MNR are interested in calculating an accurate parity price, it is necessary.

6. It is recommended that the MNR provide sufficient funds to obtain the required Worldscale flat rates and the monthly AFRA ajustment for clean MR class vessels (25,000-44,999 MT). If there is a MR class AFRA adjustment for a 25,000-

30,000 MT vessel, that is the AFRA to be used. AFRA will stop publishing adjustments for GP class vessels (16,500-24,999 MT) in July, 1994 so GP AFRA's can not longer be used. Sometimes a premium is added to the AFRA for vessels transporting clean products as opposed to those vessels transporting black products. Such premiums are added to the AFRA before multiplying by the Worldscale flat rate.

7. Part of the parity price build-up is to determine the cost of working capital involved in importing ideal-sized cargoes. Based on the product demand forecast for 1994, a 25,000 DWT tanker would contain 11,770 MT of petrol, 4910 MT of dual purpose kerosene and 8320 MT of diesel, representing the Uganda product requirements for 30.7 days. The value of such a cargo would then be calculated using the two-month average FOB prices plus ocean freight for each product. The cost of working capital for this cargo can then be determined using a one year LIBOR (London Interbank Offered Rate) interest rate (currently 4.3125%). This would be determined as follows:

$$\frac{30.7 \text{ days}}{365 \text{ days}} \times \text{LIBOR} \times \frac{\text{Total US\$ Value of Cargo}}{\text{Total Cargo Volume, MT}} = \text{US\$/MT}$$

This cost should then be added to the landed CIF cost for each product in the parity price build-up for monitoring purposes.

8. All the handling, transit and product loss charges as shown in Table 2 are to be used and updated as necessary. The percentage of products being moved to Uganda from Kenya and from Tanzania should be obtained from the Uganda Revenue Authority (URA) who have compiled this actual data. Also, the URA have actual data on the quantities moved by rail and by road in order to apply the correct average overland transportation rates. All transportation rates should be updated regularly.

9. The CIF Kampala cost of each product calculated by this parity price build-up outline in Table 2 can then be compared to the actual costs incurred by the oil companies. Since portions of the CIF Kampala cost for the oil companies are covered by various invoices (ie. inland transportation billed and paid separately), it will be necessary to obtain the actual data regularly from each of the oil companies who must understand that the information will be held confidentially.

10. In the event that the resultant monitoring indicates that the oil companies are being over-charged by their suppliers (compared to FOB posted prices) or their providers of ocean freight (compared to the ocean freight calculations, while considering their two port discharge operations), it will be necessary for the MNR to have a meeting with them and warn them of the consequences of not demonstrating sufficient competitiveness. A total competitive market is not a regulated market. However, if competitive forces are not working, the only alternative would be to threaten the return to regulated prices.

Table 2: Parity Price Build-Up

1. FOB Posted Prices (Two month ave., see para. 4.3)
2. Ocean Freight (Two month ave., see para. 4.4)
3. Cost of Working Capital (see para. 4.5)
4. Insurance (0.035% of FOB + Freight)
5. Ocean Loss (Petrol 0.5%CIF, Kero 0.4%CIF, Diesel 0.3%CIF)
6. Demurrage (Based on an actual year cost)
7. Wharfage (1.5% of CIF)
8. KPRL (Refinery Batching Fee) US$1.08/MT (Mombasa source only)
9. SGS Inspection Fee 3.85 Ksh/MT
10. Mom./Narb. Pipeline Fee 1000 Ksh/m^3 (Mombasa source only)
11. Mom./Narb. Pipeline Loss 0.2% all products (Mom. source only)
12. Nairobi Terminal Thruput Charge US$8.00/$m^3$ (Mom. source only)
13. Dar Terminal Thruput Charge US$7.00/$m^3$ (Dar source only)
14. Terminal Product Loss (0.9% Petrol, 0.35% Kero/Diesel)

Road Transportation, Nairobi-Kampala

15. Road Transport to Kampala US$60/$m^3$
16. Temp. License (for Uganda trucks) US$0.83/MT
17. Product Loss Allowed by Road (0.3% petrol, 0.2% Kero/Diesel)

Rail Transportation, Nairobi-Kampala

18. Rail Transport to Kampala US$53.38/MT
19. Product Loss Allowance (1% Petrol, 0.5% Kero/Diesel)

Rail Transportation, Dar-Kampala

20. Transport($53.74/$m^3$ Petrol, $55.50/$m^3$ Kero, $59.25/$m^3$ Diesel)
21. Product Loss Allowance (1% Petrol, 0.5% Kero/Diesel)

Pipeline, Mombasa-Eldoret

22. Mombasa-Eldoret Pipeline Fee US$46.50/MT
23. Also, required to include Nos. 8, 9, 11, 12, and 14 from above with 12 and 14 representing costs through the Eldoret Terminal

Rail Transportation, Eldoret-Kampala

24. Rail Transport US$30/MT
25. Product Loss Allowance (1% Petrol, 0.5% Kero/Diesel)

Service Station Pump Price Monitoring

11. It is suggested that the MNR request the oil companies to provide pump price data each week for their various service stations locations. Since the oil companies have this data and it is in the public domain, there should be no reason for them not to comply. This would be the easiest way to collect this data.

HOW WOULD AN ICB OPERATE?

1. An ICB should be operated as a proper corporation. In this manner, there are no problems associated with transfers of title or whether some companies are taking on the financial responsibilities and obligations of other companies. ICB's have been successfully operated by a consortium of the oil marketing companies in which each company's share is based their market share. In the case of Uganda, a consortium would have to have a capitalization of about US$ 10 million (sufficient for two 25,000 MT cargoes, one to Mombasa and one to Dar). The consortium would always be managed by a General Manager and an Assistant General Manager from two different oil companies. These positions would be rotated to each of the oil companies every 6-12 months, at their convenience.

2. A Bidding Committee would be formed that would include the two representatives of the consortium, a member from the Ministry of Natural Resources (the Petroleum Commissioner), and a representative each from the Ministry of Finance and the Bank of Uganda. It is important to keep the Bidding Committee small and manageable and with sufficient expertise to understand the value of various product quality specifications and familiarity with the supply and transportation aspects of the oil business. Requests for tenders would be sent to 10-12 reputable suppliers each year and the lowest two supplier bids would share the requirements of Uganda for that period. Two suppliers are used to minimize risk of supply. One year is used because this ties in with how the major oil companies contract for new supplies and shipping. Yearly contracts will still reflect any changes in FOB prices during the year because the tenders will be based on posted prices on the date of loading plus/minus some fixed amount.

3. The request for tender would be a very simple two page fax which will include:

a. Quantities of premium gasoline, diesel and dual purpose kerosene representing six months requirements but to be delivered over one year.
b. Product specifications.
c. Deliveries to be CIF Mombasa (Kipevu pier) and CIF Dar es Salaam in 20-25,000 MT cargoes.
d. Quotations to be US dollars/metric ton with Platt's posted prices used as reference.
e. Advice that the award will be given to each of the two lowest bidders.
f. Payment will be made 30 days after date of loading by irrevocable Letter of Credit confirmed by an international bank acceptable to the seller with confirmation to be given at least five days prior to loading (It is doubtful that a consortium would get the necessary credit for payment without a Letter of Credit).
g. Bid to be valid for 30 days.

h. Successful bidders will enter into product supply contracts with the consortium during the 30 days.

4. Petroleum product supply deliveries would be made into the KPC Terminal in Mombasa and into the Bulk Oil Terminal in Dar where title would pass to the consortium. Because of the current KPC requirement that the pipeline will only pump product owned by a Kenyan company, the consortium would sell the product to KPC for deliver in the KPC Terminal in Eldoret. Otherwise, a waiver to this exclusion would have to be obtained. The best method would be to obtain the waiver to avoid the consortium from doing business in Kenya (buying and selling). The consortium would be responsible for all inland transportation and would sell to the oil companies CIF Kampala. This price would include the CIF port terminal cost, ocean losses, any demurrage incurred, wharfage charges, handling charges at the terminals, all inland transportation costs and product losses at all the terminals and inland transportation methods. The price would also include a fee for operating a consortium (described below).

What Would an ICB Operation Cost?

5. As mentioned in Paragraph 3.2, the consortium would have to have a capitalization of at least US$ 10 million. A fair return would have to be given for that investment, such as 15%, which, after a 30% income tax, would amount to a charge of US$ 2.14 million per year. The consortium would have an office with about 7 people in addition to management (Office Manager, Transportation Coordinator, Secretary, two Clerks handling about 40 invoices/day and two Product Loading/Discharge Coordinators handling the specific product loading/discharge requirements of six oil companies each day). The office would have two radios, five telephones and a fax machine. The office could cost US$ 200,000 per year. The actual cost of the Letter of Credit or about 2.5% of the landed CIF cost would also have be recovered amounting to US$ 1.1 million in 1994. The total amount that would be added as a fee to operate a consortium would then be about US$ 3.44 million/297 million liters or 1.16 US cents/liter (this represents the petrol, kerosene, turbo fuel and diesel volumes expected for 1994).

POLLUTION FROM PETROLEUM PRODUCT WASTES

Background

1. Used fuel oil and petroleum lubricants are technically regarded as toxic and hazardous waste. Their improper disposal on land or into surface water supplies imposes a potential health hazard to humans, as well as threatening environmental capital. Improper waste handling can, for example, lead to loss of economic fisheries, contamination of soils important to urban and rural agriculture, fouling of water supplies making them unfit for domestic or industrial applications, and generally unsightly surroundings. A common problem with petroleum product wastes is that they are often disposed of in small quantities and the cumulative effects over many years can be quite significant. The costs of reversing the damage done by improper disposal typically far outweigh the costs associated with prevention of the impacts in the first instance; moreover, many 'preventative' measures are commercially viable and do not incur net costs in their disposal.

2. In Uganda, good operating practices have generally prevailed in the handling of product wastes. A survey demonstrated that a significant number of market and non-market incentives exist that effectively reduce wastes (box below). These inherent incentives can generally be summarized as: a) Good citizenship. In the interests of a positive market image, many operators follow sound waste disposal techniques to attract customers. b) Opportunities for own-use. Many of the waste products can be used within internal operations to reduce other operating costs. Shell uses selected wastes as weed killer and Total uses separated wastes as fuel. c) Existence of secondary markets: Very good secondary markets exist for separated fuels, for lubricants and oils in the treating of posts and poles, or for input to brick-making. For example, the railyard workshop sells approximately 20 drums of used diesel engine oil a month for UgSh10,000 each to local foundries. The implicit 'tax-free' status of these fuels provides an effective incentive to purchasers to use them where possible. d) Significant awareness of benefits of good housekeeping practices. Most operators appear to be aware of immediate local benefits from proper waste management. For example, the railyard workshop sources its own water supply from shallow aquifers, which would become almost immediately polluted if proper waste handling did not occur. In spite of these trends, there are still a limited number of operators who do not follow such practices. Also, some sludges are presently being stored which have no immediate use and no apparent market.

Assessment of Options

3. As noted previously, the situation is not one of grave concern or high priority. The major goal of any policy intervention should therefore be to ensure that appropriate preventative measures are followed. Possible interventions include: (a) Waste management regulations. These "command-and-control" style regulations would provide regulatory protocols on what practices should be followed in handling and managing waste products. (b) Market-based incentives. Such incentives are based on the "Polluter Pay Principle" (PPP) and

generally involve incentive mechanisms such as taxes, bonding requirements, user charges, or refund/deposit schemes. They may also involve liability legislation that allows damaged parties to recover damage costs from the polluter. (c) Specific public investments. Where large volumes of intractable wastes are involved, public investments in common waste handling infrastructure may be required. (d) Reporting regulations. These "minimalist" regulations require operators to report the volumes of waste being handled, but do not regulate the actual disposal of the waste. At this stage, the low severity of the problem, coupled with budget and manpower constraints, require that interventions not involve aggressive and costly programs. For this reason, strict waste management regulations that require constant policing and monitoring are not appropriate; similarly, public investments in infrastructure are not readily justified.

Conclusions

4. In the near term, the use of regulations that require reporting would effectively encourage awareness and facilitate on-going monitoring. Over the longer-term, it may also be appropriate to introduce PPP-based incentive mechanisms to encourage efficient economic management and sound environmental management. The rationale for such incentives is straightforward: they generally have substantially lower social and economic efficiency costs than the traditional command-and-control approach of strict regulatory systems. In Uganda, there are additional compelling reasons for pursuing this course of action. Early versions of draft environmental legislation for Uganda placed a high priority on the use of incentives. The final environmental policy statement therefore also includes a commitment to the use of such incentives for environmental management. However, during the redrafting of the environmental legislation under NEAP, a strong traditional "command-and-control" bias entered the legislation, and there are few explicit provisions for "incentives". The implementing regulations (which follow from this legislation) are still being formulated. There is, therefore, an opportunity to provide some key input over the next decade in the area of incentive design.

Survey Of Petroleum Product Waste Management Practices In Uganda

A survey of waste management practices in the Kampala area demonstrates that, for the most part, good waste management practices are being followed. Also, spot checks conducted at petrol stations in the Western and Eastern regions of Uganda generally demonstrated that good practices were being followed.

Operator	Waste Disposal Practice (Jan/Feb 1994)
Uganda Transport (buses)	Used diesel engine oil (60 litres/week) dumped to sewer
Uganda Cooperative Transport (trucks)	Used diesel engine oil (300 litres/week) trapped, drummed and sold for pole and post treating Used gear box and transmission oil (60 litres/week) trapped, drummed and sold for pole and post treating
Uganda Railway Shops (locomotives)	Used diesel engine oil (up to 1000 litres/week) trapped, drummed and sold to local foundries
Shell (retail dealers)	Used crankcase and gearbox oils trapped, drummed and sold for pole and post painting disposal at dealer initiative, no centralized collection
Shell (loading terminals)	Waste sludge collected via interceptors in drains sold for brick-making, own-use for weed-killer
Caltex (retail dealers)	Used crankcase and gearbox oils trapped, drummed and sold for pole and post painting disposal at dealer initiative, no centralized collection
Caltex (loading terminals)	Waste sludge collected via interceptors in drains collected by Kampala City Council truck final disposal not known
Esso (retail dealers)	Used crankcase and gearbox oils dealers required to trap and drum all waste drums returned to Kampala Terminal to special "slop" tank
Esso (loading terminals)	Waste sludge collected via interceptors in drains, decanted to "slop" tank API separator on all waste water draw-off "slop" tank contents being held; no disposal plan in place
Agip (retail dealers)	Used crankcase and gearbox oils trapped, drummed and sold for pole and post painting disposal at dealer initiative, no centralized collection
Agip (loading terminals)	Waste sludge partially collected via interceptors in drains final disposal not known
UPET (retail dealers)	Used crankcase and gearbox oils trapped, drummed and sold into secondary market
UPET (loading terminals)	Waste sludge partially collected via interceptors in drains final disposal not known
Total (retail dealers)	Used crankcase and gearbox oils trapped, drummed and sold for pole and post painting disposal at dealer initiative, no centralized collection
Total (loading terminals)	Waste sludge collected via interceptors in drains API separator on all waste water draw-off all collected material decanted and returned to fuel oil

AIR POLLUTION FROM VEHICLE EMISSIONS

Background

1. Air pollution in Uganda is often discounted as an environmental problem, and, to date, no inventories, monitoring, or emission estimates have been undertaken. This lack of data complicates the assessment of priorities in this area, but the availability of statistics on related activities (such as petrol consumption) provides a basis for estimating emissions from various sources. Vehicle emissions are the major source of pollution, as 80% of diesel fuel is used in the transport sector, and 100% of petrol is used in this sector. Lead is probably also an important pollutant from petrol, as only leaded petrol is imported into the country. Diesel fuel is a source of sulphur oxides (SOx) and of particulates because in Uganda automotive diesel fuel is among the highest sulphur fuels available. All three of these pollutants -- lead, sulphur, and particulates -- are known to create chronic health problems through respiratory diseases or other illnesses.

2. It is difficult to measure the true risk of such pollutants because it can take extended periods of exposure before ill effects are noticed. Moreover, ambient air quality monitoring does not usually give an accurate reading of the ultimate health impacts of a problem. Finally, when anticipated growth in pollutants is very rapid, and when control measures to prevent pollution from occurring can only be phased in over long periods of time, it is not unusual for there to be a prolonged period during which exposures exceed safe limits.

3. To illustrate the growth in pollutants, a model of emissions was developed, tied to the Base Case and High Case forecasts of petroleum product demand, to estimate the total emissions of key pollutants from the transport sector (Annex A5.2). The methodology reflects forecasts of vehicle mix (for both petrol and diesel vehicles), forecasts of road use per vehicle, and forecasts of vehicle fuel efficiency. Based on typical fuel attributes (such as lead content or sulphur content) the emission levels of key pollutants can be estimated through emission coefficients. Figure 5.1 shows the estimates of emissions of the various pollutants in the years 2000 and 2012 relative to a 1993 base year. It is clear that, in all cases, emission levels will be growing rapidly.

Assessment of Options

4. Although emission levels will increase, the impact on human health will depend on many factors related to the dispersion of these pollutants. The type of intervention that is appropriate depends, to a large degree, on the actual health risks associated with the pollutant. Measures taken elsewhere to deal with these pollutants include interventions such as: (a) reduction or phase-out of lead content in fuels; (b) reformulation of diesel fuels to decrease sulphur and particulates; (c) traffic management interventions to reduce congestion; and (d) filtering methods.

HEAL: Human Exposure Assessment Location Project -- A Model for Lead Monitoring

HEAL was initiated by the World Health Organization (WHO) and the United Nations Environment Programme (UNEP) as a project to measure directly the effects of environmental pollution on humans. Traditionally, pollution monitoring has been concerned primarily with the source of pollutants and their movement through the environment. This source-oriented monitoring provided little information about how much of a pollutant actually comes in contact with people. Moreover, mathematical modelling of traditional monitoring data generally does not provide good information on human exposure. Besides considering the pollutant source and mode of transport, it is necessary to examine the whole sequence of events from when a pollutant is emitted to how it affects humans and the environment. Directly measuring human exposure is an essential element in accurate risk assessment. This ensures the establishment of proper, cost-effective control standards, designed to protect human health.

In its pilot phase, HEAL monitored three groups of chemicals (heavy metals, organic chemicals, NO2) in seven countries (Brazil, China, India, Japan, Sweden, USA, and Yugoslavia). The program has since been extended to be available in all countries.

Lead is one of the heavy metals for which an appropriate exposure protocol was developed and extensively tested. The procedure involves studies on individual subjects over a seven-day period that essentially consists of three components:

Inhalation Monitoring. One source of lead is through inhalation. It is estimated by measuring the concentration of metals in the breathing zone of each subject using low-volume personal air samplers.

Dietary Exposure. A second potentially important source of lead is through diet. This may occur from drinking water, from contaminated foods, or from food cooked in contaminated water. Estimates of lead exposure are determined from a duplicate diet technique (which involves collecting and analyzing duplicate portions of all materials ingested). Estimates are validated through analyses of feces.

Total Exposure. Total exposure monitoring is conducted through blood testing at the end of the seven-day test period.

A number of controls are necessary to ensure that sampling is accurate. For example, the study sample must consist only of non-smokers, as inhalation of tobacco smoke may be one source of lead intake. Also, quality assurance in the sampling protocols for collecting the duplicate diet require that acid-washed plastic containers be used for collection. In cases where the mechanism of exposure (inhalation or diet) is not of consequence -- or can be established from other information -- a blood testing program may be adequate to determine the degree of risk and extent of exposure. In this case, it is appropriate to identify high risk groups that are exposed to the pollutants for greater periods of time. Individuals working at street level -- such as hawkers or drivers of public transit vehicles -- often have the greatest exposure. School-aged children are also generally regarded as those being at greatest risk; this is because the effects of lead contamination are cumulative, and because they typically spend proportionately more time outdoors at street level than do adults.

5. Given that petroleum products are wholly imported, any long-term changes in fuel specification could be beneficially coordinated with similar interventions in Kenya or Tanzania. The desirability, or necessity, for such measures should be evaluated only after the likely health impacts are known and the costs of selected interventions are better defined. Some programs, such as reducing the sulphur content in diesel, will have economic benefits to fuel users as it will reduce the maintenance costs on engines. Also, many options are available to reduce lead in gasoline without reducing the octane rating. An evaluation of these options will depend both on factors within Uganda and those outside such as the availability of fuels in international markets.

6. In the short-term, there are essentially two options for determining the extent to which these three pollutants -- lead, sulphur and particulates -- are indeed a problem. The first approach is dose monitoring, which involves measuring the actual dose levels of a pollutant in individuals. The advantage of this approach is that it can be done rapidly and cost-effectively, and it provides an immediate indicator of whether safe doses are being exceeded. The second approach is ambient air quality monitoring. This is much more costly, and takes longer for results to become well-defined. Its advantage is that -- once the monitoring network is in place -- it provides long-term baseline information relating to air quality from a number of pollutants. Experience elsewhere has demonstrated that dosage methods are appropriate for lead monitoring but that, given long-term monitoring requirements, ambient air quality measures are the most effective methods for sulphur and particulates.

Conclusions

7. As health impacts must be measured before a detailed long-term program can be devised, high priority must be given to implementing appropriate monitoring programs for lead, sulphur and particulates. Testing of high-risk groups (e.g., blood testing of school children in urban centres and transport corridors) must be given a high priority; an appropriate model for this has been devised by WHO/UNEP (Box 5.3). Also, ambient air monitoring of sulphur and particulates in the Kampala area would provide an indicator of the extent to which these pollutants are a potential health threat.

WATER POLLUTION FROM PETROLEUM PRODUCT SPILLS

Background

1. The primary issue is possible water pollution from spills of petroleum products into water bodies, or spills from improper handling of toxic wastes. Investigations of activities at the Jinja strategic storage depot, the Port Bell ferry, the railyards, petrol retail outlets, and selected bus companies show that: (a) major spills and losses have not occurred, largely because of relatively good operating practices; and (b) the most significant risks of spill exist at the Jinja depot and the Port Bell ferry but, the most significant risk is to human health rather than to environmental quality.

2. In spite of the good record to date, the actual risks of a spill occurring on Lake Victoria may increase over the next decade because of two factors. First, the amount of petroleum product using the Mwanza-Port Bell ferry will increase substantially. Second, external factors such the encroachment of Water Hyacinth into Lake Victoria will increase the length of time that ships use for docking manoeuvres, when they are generally at greatest risk to accident. It is notable that, at present, no mechanisms are in place for reacting to an accident. In general, therefore, two types of intervention will be required to mitigate the impacts: (a) preventative measures to reduce the risk of spills; and, (b) measures to contain the impacts of a spill in the event that one does occur. Because of the high cost and general ineffectiveness of oil spill contingency planning, a greater emphasis should be placed on prevention.

Assessment of Options

3. In the area of preventative actions, numerous options are available for reducing risk. For a start, encouraging good operating practices is an appropriate form of preventative regulation that can be readily policed. An appropriate model for this is the International Maritime Dangerous Goods (IMDG) Code, which is an international protocol developed by the International Maritime Organization (IMO) for the safe handling of dangerous substances transported via water (see box below). For example, the Code recommends that all containers carrying dangerous substances bear an internationally identifiable placard. Placards are diamond-shaped, colour-coded and symbol-coded according to the nature of the substance. The class number of the substance must be visible in the bottom of the placard; if the substance is a "marine pollutant," a sign so indicating must be attached to the outside of the container. Also, a 4-digit product identification number (PIN) exists for each type of dangerous substance. A number is usually preceded by the letters UN indicating that it was assigned by the United Nations. The PIN must be visible on the outside of the container, as well as on the shipping documents. First responders to an accident must be familiar with these identification numbers and placards so that appropriate spill response procedures can be

followed. Detailed procedures for spill response are outlined in manuals referring to specific PIN and Class categories.

4. In addition, a longer term policy initiative could be to require polluters to pay for any damages that arise because of upsets or accidents. In the case of the ferry operation, such costs would ultimately be borne by the product consumer in the form of a higher product price arising from higher transport costs. Such mechanisms are currently premature, however, as they require a well-established system of litigation.

5. In the area of oil spill contingency planning, different systems and options are again available. Ship-based systems are intended to be self-contained and readily available at the site of an accident. Their overwhelming disadvantage is that, when a spill or accident occurs, the ship is itself often damaged and the equipment is often destroyed or otherwise made unusable; moreover, the crew on board a ship in distress will generally have human safety concerns as a first priority and therefore do not make an effective emergency response team in the event of a spill. Shore-based systems are therefore in more common use; these are based on custom-designed protocols for emergency spill response, and include: identification of 'at-risk' sites, specific procedures to be followed for equipment deployment, regular training and drill work. It is important to note that the major cost of oil spill contingency programs is not the equipment cost. Such costs are modest, as described in Chapter 2. The major cost is typically the on-going training and drill work required for effective spill response. It is for this reason that many jurisdictions have delegated this duty to the military, or other civil defense or existing emergency response force. In Uganda, the situation is complicated by the fact that spill response could be improved greatly through a cooperative effort between Tanzania, Kenya and Uganda. The lack of any such cooperative effort will severely curtail the effectiveness of any response.

Conclusions

6. The most cost-effective approach for reducing the risk of spills and water pollution is to rely first and foremost on preventative measures. Adoption of the IMDG Code provides an appropriate model that can be implemented immediately by ship operators on Lake Victoria. Over the longer-term, it may also be desirable to introduce PPP-based incentives or other liability mechanisms. Also, shore-based oil-spill contingency planning for the Lake Victoria area should be put on the agenda of all regional watershed management initiatives. This would include, for example, the World Bank Global Environment Facility [GEF] project and the regional "Nile 2002" initiative. In the interim, basic investments in shore-based equipment and training of an appropriate response team (e.g. military) could proceed unilaterally in Uganda.

International Maritime Dangerous Goods (IMDG) Code

The IMDG Code was developed by the International Maritime Organization (IMO) in London for the safe handling of dangerous substances transported via water. The Code classifies dangerous substances according to their physical properties, and for each classification it provides guidelines for product identification, stowage, segregation, packing, ullage limits, fire precaution & emergency procedures, and first aid. The following illustrates elements of the IMDG Code for the marine movement of tank cars containing: petrol, aviation fuel, gas oil, and kerosene (see IMDG Code for complete information).

Product Identification and Placarding

* Petrol, aviation fuel, gas oil (diesel) and kerosene fall into Class 3 -- "Flammable Liquids."
* Containers carrying these fuels should bear a red diamond-shaped placard depicting a flame, and the number "3" should appear in the bottom of the placard.
* All of these fuels are "marine pollutants," hence a triangular-shaped sign with the marine pollutant symbol (a fish with a superimposed "X") should also be attached to the outside of the container.
* Product identification numbers (PIN) are: Motor Spirits including Petrol -- UN1203; Aviation Fuel -- UN1863; Gas Oil (Diesel) -- UN1202; and Kerosene -- UN1223. PIN numbers should be placed on or beside the placard.

Stowage of Units (tank cars) on Board Roll-on Roll-off Ships

* Units of dangerous goods should be stowed such that they are always accessible, especially for fire fighting.
* On Deck or Under Deck for cargo ships carrying no more than 25 passengers, or 1 passenger per 3 meters of overall length whichever is the greater number.
* For stowage on passenger ships: Class 3.1 (Petrol) is Prohibited; Class 3.2 (Aviation Fuel) is On Deck Only.
* Where stowage "on deck only" is required, preference should be given to the stowage of units loaded with marine pollutants on well-protected decks or to stowage inboard in sheltered areas of exposed decks.

Securing of Cargo Transportation Units

* On roll-on roll-off ships carrying dangerous goods, all units should be securely fastened to the ship with lashings, or other suitable means, to preclude shifting of units when the ship is in a seaway.

Segregation

* Incompatible goods must be segregated. Two substances are considered mutually incompatible when their stowage together may result in undue hazards in the case of leakage or spillage or any other accident.
* Segregation arrangements should vary in accordance with the extent of hazard arising from possible reactions between incompatible dangerous goods.

Packing or Loading of Dangerous Goods into a Unit

* The load carrying portion of a unit (tank car) carrying dangerous goods should be visually inspected before loading; if there is evidence of damage, the unit should not be loaded.
* Design, construction and operation of tanks should be in accordance with Code Section 13.
* All vehicles intended for the transport of Class 3 substances should be closed tanks and fitted with pressure relief devices designed and operated in accordance with Code Sections 13.1.9 to 13.1.16.

Ullage Limits

* The vapour pressure of liquids with a low boiling point is usually high, hence the strength of receptacles for these liquids should be sufficient to withstand, with a safety factor, internal pressures likely to be generated.
* Unless specific requirements are prescribed in national or international rules, agreements or recommendations, liquids should not completely fill a packaging at a temperature of 55C.

Fire Precaution & Emergency Equipment on Board

* Adequate ventilation must be provided to prevent accumulation of vapours. Flammable vapours from flammable liquids, if ignited may cause "flashback" to where the substances are stowed.
* Protective clothing (gloves, boots, coveralls, headgear).
* Self-contained breathing apparatus.
  Spray nozzles.

Emergency Action

* Avoid all sources of ignition (e.g. naked lights, unprotected light bulbs, electric handtools).
  Turn ship off wind.
* Spillage On Deck: Wash spillage overboard with copious quantities of water.
* Fire on Deck: Use water spray, foam or dry chemical. Do NOT use water jet. If possible remove receptacles likely to be involved or keep them cool with copious quantities of water.

ALTERNATIVE PETROLEUM SUPPLY ROUTES

The following four alternative routes were originally considered:

1. **Pipeline to Eldoret/rail-ferry:** Kenya-source; rail and truck from the pipeline terminal in Eldoret. Tanzania-source; rail for the total route, using the rail-ferry across Lake Victoria.

2. **Pipeline to Port Belll/rail-ferry:** Kenya-source; new clean products pipeline from Eldoret to Port Bell. Tanzania-source; rail for the total route, using the rail-ferry across Lake Victoria.

3. **Pipeline to Kisumu/rail-ferry:** Kenya-source; self-propelled barge from Kisumu to Port Bell. Tanzania-source; rail for the total route, using the rail-ferry across Lake Victoria.

4. **Pipeline to Kisumu/barges:** Kenya-source; self-propelled barge from Kisumu to Port Bell. Tanzania-source; rail to Mwanza, then by self-propelled barge to Port Bell. But, use the existing rail-ferry across Lake Victoria up to its capacity.

5. Before assessing these alternatives a brief review is made of the capacity of the URC to carry products. It is dependent on the turnaround time of handling tank wagons, including the shunting operations on the loading and unloading sidings. The current round-trip transit times are shown in Table 1.

Table 1: Round-Trip Transit Times, Days

	Dar es Salaam		Nairobi	Eldoret	Mombasa	
	Rail	Truck	Truck	Rail	Truck	Rail
To Kampala	7	3	1	3	4	7
From Kampala	7	3	1	3	4	7
Loading	2	1	1	2	1	2
Unloading	2	1	1	2	1	2
Total	18	8	4	10	10	18

Source: Oil companies.

6. The Dar route, with the existing URC equipment, should be able to handle 155,000 t/year or 539 m^3/day of clean products (including 13,000 t/year of aviation fuel via 20 dedicated tank wagons). The capacity of the three ferries will allow 188,000 t/year to be carried while still carrying 50% dry cargo. At present they carry 60% dry cargo.

7. Given the estimated capacity on the Dar route, it is not necessary to analyze Alternative 4 because it is in practical terms covered by Alternative 3. This is because the rail-ferry operation will continue for dry cargo movement, whatever alternative is chosen for petroleum products. Consequently, with the rail-ferry being in

operation, there is the built-in capacity of transporting 155,000-188,000 t/year of products without any additional investment for use of a self-propelled barge from Mwanza, which would include a large terminal, loading facilities and a dock at Mwanza. Alternative 4 would only be relevant if more than 188,000 t/year were moved on the Tanzania route. Under Alternative 3, assuming the Base Case, about 40% of the forecast volumes in the year 2005 could be moved, and even in the High Case, 20% could still be moved via the rail-ferry in 2010.

8. Alternatives 1, 2 and 3 are appraised below, under conditions of forecast demand according to the Base Case and the High Case. Alternative 1 is a continuation of the existing arrangements but requiring additional facilities such as trucks and tank wagons. Alternative 2 assumes that Kenya sourced products go through a new pipeline, to be completed in the year 2000, between Eldoret and Port Bell. Alternative 3 assumes that Kenya sourced products use the pipeline to Kisumu from where they go, beginning in 1997, by self-propelled barge to Port Bell. In all alternatives the Tanzania sourced products continue to move on the existing systems of rail and rail-ferry. Port Bell is assumed to be the location of all new tankage, terminals and loading/unloading racks. Thus, all new and eventually all storage would be at Port Bell which would become the country's main petroleum terminal and storage centre.

Evaluation of Alternative Supply Systems: Base Case

9. **Alternative 1:** The existing system will call for additional tank wagons and locomotives in the year 2001 (investment to be made in 2000). It was assumed that beginning with the year 2000, US$2 million would be required every other year for bridges, sidings, rails, etc. Over the forecast period (through 2010), a total of 225 new tank wagons and 14 locomotives will be required. It was assumed that the maximum product available at Eldoret would be 75% of the portion KPC has allocated for export (1875 m^3/day, the remainder being allocated to Rwanda and eastern Zaire). The private sector would provide new investment for the trucking capacity needed over the period (174 trucks for US$27.9 million). This alternative has 26% of the clean products coming from Tanzania in 2010 and 39% of the products moved from Eldoret was by rail. Considerable investment is needed in this alternative for trucks, tank wagons and locomotives.

10. **Alternative 2:** A new six inch pipeline is constructed from Eldoret to Port Bell in 1999 and 2000. Rough economics were developed on the pipeline operation of this alternative and indicated an IRR of 5%. This was based on a revenue of US$30/ m^3 (US$38/t) and an operating cost of US$12/ m^3 (0.06 US cents/t/mile). Based on a product availability of 2500 m^3/day from Eldoret, there is sufficient product until 2013. This alternative also has 26% of the clean products coming from Tanzania in 2010.

11. **Alternative 3:** A self-propelled barge operation begins in 1997 transporting products from Kisumu to Port Bell. The facilities required at Kisumu and Port Bell were constructed in 1995 and 1996. Additional barges were provided in 2000

and 2006. In this alternative, 26% of the clean products are being imported from Tanzania in 2010. An economic analysis of this alternative was developed based on revenue for the barging operation to be equal to the rail tariff (US$25.50/ m^3) from Eldoret to Kampala. This produced an IRR of 20.1% when including the US$2.0 million investment required at Kisumu and assumed to be done by KPC.

Evaluation of Alternative Supply Systems: High Case

12. **Alternative 1:** will start to need additional tank wagons and locomotives in 2000 (investments made in 1999). Beginning in 1999, US$3 million would be required every other year for bridges, sidings, rails, etc. It was assumed that the maximum products available in Eldoret would amount to 75% of the total portion allocated by KPC for export (1875 m^3/day). On this basis, the maximum throughput to Eldoret is reached in 2008 and additional volumes are imported from Nairobi. Over the forecast period (through 2010), an additional 335 new tank wagons and 20 locomotives will be required. The new investment for trucking needs, amounting to 309 trucks costing US$49.4 million, will be provided by the private sector. The oil companies terminal at Port Bell would be started in 1998. In 2010, 20% of the clean products are being transported from Tanzania. In this alternative, huge investments are required for trucks, tank wagons and locomotives.

13. **Alternative 2:** The new pipeline from Eldoret to Port Bell is constructed in 1998 and 1999. Based on a product availability of 2500 m^3/day from Eldoret, there is sufficient product until 2010. In 2010, some 28,000 t are needed to be trucked from Nairobi. 20% of the clean products are coming from Tanzania in 2010.

14. **Alternative 3:** Assumes a self-propelled barge operation transporting products from Kisumu to Port Bell begins in 1997. The required facilities in Kisumu and Port Bell were constructed in 1995 and 1996. Additional barges were provided in 1999, 2004 and 2008. In this alternative, 20% of the clean products were transported from Tanzania in 2010. The third supply source through Kisumu provides added security of supply to Uganda and is actually needed in the long-term as the availability of product that is allocated for Uganda in Eldoret is exceeded.

Evaluation of Alternative Supply Systems: Summary

15. Both Alternatives 1 and 2 are investment intensive, and especially Alternative 2 because of its pipeline investment. The public and private investments were combined year-by-year for all alternatives and discounted at 12%. These results are shown in Table 2. Alternative 3 is the least investment intensive and, as shown in Annex XII, the barge operation could be profitable.

Table 2: Public and Private Investments Discounted at 12%
US$ Millions

	Base Case Volumes			High Case Volumes		
	Alt 1	Alt 2	Alt 3	Alt 1	Alt 2	Alt 3
Discount at 12%	34.1	56.5	25.2	53.6	65.8	28.9

16. Assuming that the cost of petroleum products at Eldoret is more or less the same as at Kisumu, the transportation tariff used for Kisumu-Port Bell of US$25.50/ m^3 (equal to the rail tariff for Eldoret-Kampala) is lower than that used in the rough pipeline evaluation of US$30/ m^3. The barge operation can be done at a lower cost and more economically. The use of rail from Eldoret is more desirable than truck transportation but is too investment intensive compared to the barge operation. On the basis of this very-preliminary analysis, the long-term least-cost supply system is Alternative 3 using self-propelled barges from Kisumu to Port Bell and utilizing all the systems that are now in place, except for the proposed new oil company terminal in Port Bell which must be provided. It may be noted that the least cost supply systems minimize the use of trucking, either through substitution by pipeline, rail or barge movements, which is the policy direction for the future. The three alternatives should be examined further by an in-depth study.

Current Capacity of the Uganda Railways
Dar es Salaam-Kampala Route

Basis:

1. Tank wagon availability is 90% (10% downtime).
2. Locomotive availability is 70%.
3. Tank wagons dedicated to Av. Fuel = 20 x 90% = 18 T/W.
4. Remaining tank wagons = 220 x 90% = 198 T/W.
5. Six tank wagons are in fuel oil service.
6. Tank wagon capacity is 37MT.
7. Blocked trains = 20 tank wagons (740MT).
8. Average clean product conversion factor: 1.27m^3/MT.
9. Each ferry requires 60 days/year of maintenance.
10. Current round-trip time is 43 hours (1.8 days).
11. Ferry capacity is 20 T/W but carry 50% dry cargo on rail cars

Capacity as Limited by Tank Wagons
365 days/year = 20 trips/year for each tank wagon 18 days/trip

Fuel Oil = 6 T/W x 37MT/Wagon x 20 trips/year = 4,440MT/year
Av. Fuel = 18 T/W x 37MT/Wagon x 20 trips/year = 13,320MT/year
Other Clean = 192 T/W x 37MT/T/W x 20 trips/yr.= 142,080MT/year
Total Clean Capacity = 155,400MT/year or 155,400MT x 1.27 m^3/MT = 197,300 m^3/year

Ferry Capacity
305 days/yr. x 3 ferries x 20 T/W per trip x 50% = 5,080 T/W/year
1.8 days/trip
5,080 T/W per year x 37MT per T/W = 188,000MT/year
or 188,000MT x 1.27 m^3/MT = 239,000 m^3/year

To go to the limit of the ferry capacity, additional tank wagons and locomotives are needed:
188,000MT/year = 254 tank wagons
37MT/T/W x 20 trips/year
254T/W - 210T/W already in clean service = 44 T/W needed = 49 T/W
90%
Tank wagon cost = US$100,000 each x 49 T/W = US$4.9 million
49 T/W = 3 locomotives
20T/W per blocked train x 70%
Locomotive cost = US$2 million each x 3 locos = US$6 million

Source: Uganda Railways Corporation.

UGANDA POWER FACILITIES

UEB's Generation Plants (Early 1994)

Plant Type	Plant	Number of Units	Total Capacity MW	Commissioning Year and Observations
Hydro	Owen Falls	10	150	1954-1968 -Four units rehabilitated and upgraded to 18 MW; -Two units upgraded; -One unit under rehabiltation; -Three units still to be rehabilitated
Hydro	Kabale	2	0.5	1963 Under rehabilitation
Diesel	Arua	2	0.275	1989
	Kapchorwa	1	0.115	1989
	Kitgum	2	0.295	1989
	Maziba	3	0.720	1990
	Moroto	2	0.480	1989
	Moyo	2	0.275	1989
	Nebbi	1	0.115	1991
	Rukungiri	2	0.370	1989
			2.645	

Main Transmission Lines

Transmission Lines

132 kV double circuit overhead:	202 km
132 kV single circuit overhead:	605 km
66 kV single circuit overhead:	80 km
33 kV overhead:	2220 km
11 kV overhead:	3890 km
11 kV underground:	92 km

Main Substations

Substation	Transformation Capacity	Observations
Kampala North	132/33kV: 45 MVA 132/11kV: 30 MVA	
Nkenda	132/32kV: 22.5 MVA	
Masaka West	132/33kV: 7.5 MVA	132/11kV: 7.5 MVA Expansion 1994
Nkonge	132/33kV: 7.5 MVA	
Tororo	132/33kV: 30 MVA	
Lira	132/33kV: 15 MVA	132/33kV: 15 MVA Expansion 1994
Lugazi	66/11kV: 7.5 MVA	66/11kV: 2.5 MVA Expansion 1994
Lugogo	66/11kV: 5 MVA	132/33kV: 32 MVA 132/11kV: 32 Expansion underway
Mukono	66/11kV: 5 MVA	
Mbarara		132/33kV: 20 MVA Expansion underway
Mutundwe		132/33kV: 64 MVA 132/11kV: 10 MVA Expansion underway

MAJOR HYDRO SITES ON THE WHITE NILE

Site	Potential Capacity MW	Potential Generation Capability GWh/year
On Nile Between Lake Victoria and Lake Kyoga:		
- Owen Falls Extension	200	500 - 700
- Bujagali	230 - 250	1200 - 1500
- Busowoko	200 - 230	1000 - 1200
- Kaligala	150 - 170	700 - 900
On Nile Between Lake Kyoga and Lake Albert:		
- Kamdini	300 - 350	1200 - 1400
- Ayago	360 - 400	2000 - 2400
- Murchison Falls (Kabalega)	450 - 550	2600 - 3500
Total Potential	1890-2150	9200-11600

Remark: Two figures are given for the generation capability because the average flow of the Nile has increased during the last 30 years and there is no general agreement over which figure should be adopted. The lower figure is based on 860 m^3/s, the average flow from 1906 to 1960. The higher figure is based on 1050 m^3/s, which was the average flow from 1960 to 1993.

ELECTRICITY TARIFFS OF JULY 1993

UEB has seven different tariffs, including two for off-peak consumption. These tariffs have been in effect since July 1, 1993, when they replaced a set of tariffs that had been put into effect on June 1, 1992. The tariffs are the following:

1. Domestic Tariff:

From 1 to 30 kWh	USh 20/kWh
From 31 to 200 kWh	USh 70/kWh
Above 200 kWh	USh 100/kWh
Fixed monthly fee	USh 1,000

2. Commercial/Small Industrial Tariff (low voltage supply up to 50 kVA):

Energy charge	USh 115/kWh
Fixed monthly fee	USh 4,000

3. Medium Size Commercial and Industrial General Tariff (Low voltage supplies in excess of 50 kVA and up to 500 kVA):

Energy charge	USh 75/kWh
Demand charge (minimum charge: 50 kVA)	
All kVA	USh 10,000/kVA
Fixed monthly fee	USh 10,000

4. Medium Size Commercial and Industrial General Tariff (Low voltage off-peak. This tariff is available to those consumers that suscribe to the tariff immediately above for supplies metered separately and taken between 11 pm and 6 am. It is subject to a special agreement):

Energy charge	USh 55/kWh
Demand charge and fixed monthly fee:	Same as above.

5. Large Industrial/Commercial Tariff (high voltage supplies with a maximum demand of 500 kVA and above, taken at 11,000 volts or higher):

Energy charge	USh 70/kWh
Demand charge (minimum charge: 500 kVA)	
First 200 kVA	USh 10,000/kVA
Above 200 kVA	USh 8,000/kVA
Fixed monthly fee	USh 15,000

6. Large Industrial/Commercial Tariff (High voltage off-peak. This tariff is available to those consumers that suscribe to the tariff immediately above for supplies metered separately and taken between 11 pm and 6 am. It is subject to a special agreement):

Energy charge	USh 50/kWh
Demand charge and fixed monthly fee:	Same as above.

7. Street Lighting Tariff:

Energy charge	USh 125/kWh
Fixed monthly fee	USh 4,000

FINANCIAL RESULTS OF UEB
(millions of US$ equivalent)

INCOME	1990	1991	1992	1993	1994
Uganda Retail Sales	7.2	10.2	16.6	25.7	47.1
Kenya Bulk Sales	1.0	0.8	1.4	0.8	0.7
Tanzania Bulk Sales	-	-	-	0.1	1.5
Total Electricity Sales	8.2	11.0	18.0	26.6	49.3
Other Income	-	0.1	0.5	0.6	1.8
Total Income	8.2	11.2	18.6	27.2	51.1
OPERATING COSTS					
Personnel Costs	1.9	2.2	2.9	7.2	12.0
Maintenance & Repair	3.1	3.0	4.6	5.7	6.9
Diesel Fuel, Transport and Travel	0.9	1.0	1.0	1.1	2.3
Miscellaneous	2.5	3.5	4.1	4.6	6.6
Depreciation	0.2	0.1	4.3	9.8	13.0
Total Operating Costs	8.6	9.9	16.9	28.4	40.8
Net Operating Income	-0.4	1.3	1.7	-1.2	10.3
Less Interest	-0.4	-0.1	-0.1	-5.0	-8.9
Net Income	-0.8	1.1	1.6	-6.2	1.4
Converted at end of year rate of Ush/US$	540	915	1217	1130	979

Source: Aide Memoire of Power III Supervision Mission, May 1995.

RECONCILIATION WITH OTHER DATA

	1990	1991	1992	1993	1994
Fixed Assets	3.9	248.6	188.6	492.0	n.a.
Accounts Receivable	6.3	5.7	11.0	20.9	34.9
Collections (Actual)	n.a.	n.a.	n.a.	21.2	28.2
Net Income	-0.8	+1.1	+1.6	+1.8	+1.9
Less Increase in A/R	n.a.	+0.6	-5.3	-9.9	-14.0
Plus Depreciation	+0.2	+0.1	+4.3	+9.8	+13.0
Uncollected Revenue	n.a.	n.a.	n.a.	-6.0	-12.2
Increase or Decrease in Working Capital	+0.6	+0.7	+0.6	-1.3	-11.3

COMMENTS

The above figures should be treated as indicative rather than as definitive because the accounts have either not been audited, or the audit reports contained major qualifications. The following comments try to estimate the effect that the amount of collections has on the financial condition of UEB; collections were reported to run at the rate of USh 2 billion per month in 1993, and approximately 60% of billings in 1994. (Currently the figures for 1990-1992 are not available). Independently of how it is reflected in the financial statements, the fact the much of the revenue is not collected results in a decrease in the working capital. This explains some of the difficulties of UEB.

Income. In line with tariff increases, the revenue has increased six-fold since 1990. Total kWh sales and number of users have increased very moderately. There is doubt as to how realistic the amount of revenue is. One reason is that a large number of users are connected to the system without having meters. The unmetered users that are registered with UEB are charged a flat fee; naturally this causes disputes, which the UEB tends to settle through "adjustments", i.e. reductions of the electricity bill. The sum of these adjustments is not known, but must be substantial, nor is it known whether it is accounted properly in the income, and in the Accounts Receivable. The unmetered users that are not registered with UEB, receive no bills and do not pay anything; their consumption is treated as part of the system losses. A check in 1995 on a part of customer files showed that 45% of the customer names were wrong or non-existent (and thus could not be expected to pay), and that 25% of the energy supplied was not being billed.

Costs. The large increase in depreciation from 1992 onwards is the consequence of a revaluation of the fixed assets. Whatever the accuracy of the valuation

(see below under Assets) the order of magnitude seems appropriate. Personnel costs have increased six-fold from 1990, while staff has only increased by 31%. The quadrupling of the individual remuneration has not produced a commensurate improvement in performance. (The last IDA mission noted that productivity had declined in the last five years). Maintenance costs have doubled; they look high at 13% of revenue. Hopefully it may be the result of trying to catch-up for what was not done in the past. Miscellaneous costs have almost tripled, but no comments can be offered for lack of details. The same applies to transport, travel and diesel fuel.

Assets. The book value of the fixed assets seems high, both as compared with the number of users served, with the energy produced, and with the sales of electricity. There may be a number of reasons, such as an overvaluation of the electric plant in service, plant held for future use, and excessive amounts of non-operating property. This book value affects mainly the allowance for depreciation. In any case the composition and valuation of UEB assets should be examined. The accounts receivable have varied in the range 70-80% of yearly billings, but not too much can be deduced from this, in view of the doubts as to the accuracy of the figures.

Results. The recorded net income has fluctuated in the range -10%+8% of sales. It has never been sufficient to cover the UEB debt service. UEB has not been able to maintain its working capital, let alone increase it to keep up with the six-fold increase in sales. The table above estimates the deterioration in 1993 and in 1994. UEB's lack of adequate management of billing and collections is at the root of much of its difficulties. The unwillingness of the users to accept UEB's rate increases is at the root of much of its difficulties. The return on capital has fluctuated between a negative value and 1%. Hence UEB's inability to finance its expansion.

ISSUES IN DISTRIBUTION

The information presented below on distribution issues in Uganda is taken mainly from two recent studies. In 1992 a study of distribution system planning, design and loss reduction was prepared by IVO International, focussing on the cities of Kampala, Jinja and Tororo. In 1994 Mr. L. Cosenza prepared an overview of the commercial and distribution performance of UEB.

Urban Distribution

The 1992 IVO study concentrated on the three cities because they represented the bulk (70%) of the electricity consumption, and included the majority (80%) of the users. The data are:

City	Number of Users (in 1991)	GWh Sales in 1993
Kampala	67,476	252
Jinja	10,312	71
Tororo	2,905	11
Sum of the three cities	79,700	334
Rest of Uganda	21,000	142
All of Uganda	100,000	476

The study estimated that system losses were 25% of energy (GWh) sent out, and 37% of power (MW). It was concluded that by balancing the loads[1] and by rehabilitating the system, the energy losses could be brought down to 11% and the power losses to 10%. The cost of the rehabilitation project was estimated at US$15 million, and the rate of return on the investment was calculated to be 37%.

Even allowing for some enthusiastic estimating, the study shows that the first target of rehabilitation should be the urban areas of the Central Region, and that the benefits are greater than those of any other electricity project.

Rehabilitation Program

The rehabilitation program was proposed to be implemented over a five year period. The investments would be divided almost equally between primary (11 kV) lines and secondary (415 V) lines. Concurrent with the rehabilitation there would be a program of standardization of design of installations, and a standardization of hardware. This is

[1] Balancing loads in a three phase system means ensuring that the loads are evenly distributed between the three conductors. This minimizes the losses.

necessary because distribution installations grow and change with the load, and must be dealt with continuously.

A meter installation program was recommended. At the time a substantial number of users were billed estimated amounts because UEB did not have meters to install. At the same time, it was estimated that there were 3,000 illegal users in Kampala; these were neither registered nor billed.

In the end, the Rehabilitation Program was not implemented. The report was submitted in 1992, with sufficient data to support a loan application, or to justify an investment by UEB. Two and one half years later no action had been taken. This may be connected with the fact that the study had been financed by an institution that later was forced to reduce its lending. It is not known whether UEB made any effort to locate another source of financing.

The customer data base is unreliable and in 1993 the number of consumers oscillated from a low of 58,000 to a high of 116,000. A grid referencing exercise was begun in 1994, to relate the customers to the grid element they were connected to. In 1994, UEB expected to have a new and accurate customer data base by mid 1994. In 1995 it expected to have it by 1996. Even the partial results are not known. A TIN, Taxpayer Identification Number, was introduced in Uganda in 1994. If UEB decides to make use of it, eventually the accuracy of the data base may improve.

Recommended Measures

Even assuming that the data base can be corrected, meters must be installed to all customers, they must be periodically tested and properly read. UEB needs about 20,000 meters to meter all its users, replace damaged meters, and meter new customers. In addition it might purchase 100 hand-held units to record meter readings. Walking lists have been prepared, and should be used for the readings. UEB should start to install meters on the outside of the user's premises to make reading easier, and tampering more difficult.

Once meters are properly read, the integrity of the data must be protected, and bills must be produced. It is estimated that the next step will be to replace the software and hardware. Selection of the best alternative will be important. A proper coordination between the staff of MIS, Management Information Systems, and the commercial staff is recommended.

Another item that needs attention is the issuance of adjustment vouchers. These are journal entries made to settle billings disputed by the users. As they have reached large numbers and large amounts, more control is needed.

A sound disconnection policy should be implemented for users who have not paid their bills. As the present practice is ineffectual, this should be given a high priority. Likewise, users who are in arrears should be pursued with all appropriate means,

including legal action. Presently this is not done forcefully enough to maintain UEB's credibility.

Cost Estimate of Proposed Measures

Some of the above recommendations involve the procurement of hardware or of software. An estimated budget is given here for procurement and measures that should be taken in the short term.

Item of Expenditure	Estimated Cost
20,000 conventional meters, 1,000 prepayment meters 100 hand held meter reading units	$1,400,000
Computer software for billing	$400,000
10,000 kVAr of capacitors for power factor correction on primary lines.	$200,000
6 man-months of training for MIS management in a well run utility.	$150,000
Total of estimated budget	$2,150,000

THE AGREED CURVE

General

The Agreed Curve is a contract between Egypt and Uganda under which, at any given level of Lake Victoria, the discharge down the Nile will be maintained at all times at the value which would have pertained at that lake level prior to the construction of the Owen Falls power station. A curve has been developed and agreed which purportedly shows what the Nile Flows out of Lake Victoria were as a function of the lake level prior to 1950, and the power station operators are to assure that the flows downstream of the station correspond to this curve under all operating conditions. The Egyptian government has an official stationed in the vicinity of Owen Falls whose only significant function is to monitor adherence to the contractual agreement.

Reasons to Review the Agreed Curve

In practice the Agreed Curve has meant that at all times a very large quantity of water is being uselessly spilled through the floodgates at the Owen Falls dam. An ESMAP mission to Uganda in 1986 recommended that the Agreed Curve should be reviewed with the objective of utilizing Lake Victoria as a long-term storage reservoir for maximum benefit to the inhabitants of the countries through which the Nile flows. A later study on the hydrology of the Nile undertaken by the consultants Acres International supported that recommendation. That study produced convincing evidence that the data on which the Agreed Curve was developed was erroneous and there is no credible justification for continuing to manage Nile flows on that fictional basis. Under the terms of the IDA Third Power Project with Uganda for the extension of the Owen Falls power station Uganda undertook to raise the matter with the other countries whose riparian rights would be affected (Kenya, Tanzania, Sudan and Egypt). To the best of our knowledge no formal discussions on the matter have taken place between the parties concerned.

Alternative Method of Operation

If Lake Victoria were managed as a reservoir, the generating capacity at the Owen Falls extension could be significantly increased. (some "back-of-envelope" calculations indicate that the economic capacity increase would be about 200 MW or more than 50% of the capacity of the extended Owen Falls station). Given that the dam and much of the requisite infrastructure already exist at Owen Falls this additional capacity would require lower specific ($/kW) investment and could be brought on stream more quickly than a new development of comparable potential anywhere in Uganda. It would also result in much more efficient conversion of the energy potential of the Nile as it leaves Lake Victoria.

Even if agreement cannot be reached between the parties concerned for management of Lake Victoria as a long term reservoir, the Bank should push for its operation as diurnal storage. Under this scenario, the total volume of water flowing out of Lake Victoria in any one day would correspond to the Agreed Curve, but the flow would vary during the day in accordance with electricity demand. That is, the highest Nile flows in any day would occur at times of power system peak and the lowest at times of minimum power demand, with the proviso that the total volume passing down the Nile for any day would be that which would correspond with the Agreed Curve. This method of operation would also allow the capacity of the extension to be increased significantly.

Control of Nile flows to utilize Lake Victoria for diurnal storage would have no obvious disadvantages of any significance. The flow variations over the day would not have discernible effects on the levels of the lake. The attenuation of the large Kioga and Albert lakes would result in the Nile flows being evened out before the river leaves Uganda. During initial construction of the Owen Falls dam, the outflow from Lake Victoria was stopped completely for about two weeks, but reports suggest that that stoppage had no effect on Nile levels in Egypt which could conclusively be attributed to the interruption of flow from Lake Victoria.

The Hydrology of the Nile

The hydrology of the Nile in Uganda is characterized by the sharp increase, in 1961-1964, in the recorded flow (see Graph 1). This was a consequence of an increase in the average level of Lake Victoria (surface: 69,000 km^2) by nearly 2m (see Graph 2). Thus, during a period of three years, the inflow to the lake exceeded evaporation and outflow by some 135 billion m^3 or about four times the volume that, on average, has flowed out of the lake in a year subsequent to the dramatic increase. Although more recent research and analysis suggests that the flow records of the pre-1962 period are flawed, there is, until now, no satisfactory explanation for the phenomenon. Since the 1960s there seems to be a trend towards lower flows. The extrapolation (based on a reasonably reliable regression) set forth in Graph 2 shows that, if the trend persists, by the year 2020, annual average lake surface elevation could be back at about pre-1960 average levels. This, however, is by no means bound to occur. The possibility nevertheless introduces a substantial degree of uncertainty, which the following analysis takes into account by using two values for the river flows to be considered available with reasonable reliability:

Table 1: Characteristics of Adopted Reliably Available Flows Qa [1]

Reliably Available Flow Qa	Frequency of Average Annual Flow Exceeding Qa According to	
	1990-1993 Record	1962-1993 Record
850 m^3/s	40%	100%
1050 m^3/s	27%	78%

[1] The present report deliberately uses the somewhat vague term "reliably available flow" and avoids using the usually more precise expression "firm flow", because the latter appears in various studies with widely differing implicit definitions.

RECOMMENDATION FOR STUDIES CONCERNING HYDROLOGICAL ISSUES OF THE NILE

There is a need to deepen the understanding of the Nile hydrology in Uganda and to assess the benefits and the feasibility of using Lake Victoria as a regulating reservoir to optimize the utilization of the hydropower potential between Lake Victoria and Lake Albert. The following points suggest some of the issues which it would be desirable to cover in the corresponding studies, for which substantial preliminary work has been done in the context of the preparation of the Own Falls Extension project:

- The studies should, if possible ,establish to what extent operation in accordance with the "agreed curve" reflects the situation before the increase in lake level and river flow in the early 1960s. In this context, they should ascertain whether the uncertainty about the flows calculated on the basis of the Ripon Falls-gauge observations can be eliminated. If the gauge curve could be corrected in a plausible way it might be possible to define another rule curve, which (i) would better reflect the pre-1962 situation than the "agreed curve" and (ii) already allow a better utilization of the existing and planned future plants. It is unlikely that such other rule curve, if it can be defined at all, would involve a substantial deviation from the presently utilized rule. However, its availability might be helpful in the envisaged discussions with the governments and the affected people in riparian countries.

- In a second step, the studies should analyze the benefits to the hydro system resulting from given deviations from the rule curve (the "agreed curve" and, if identified, the above "more accurate curve"). This should be done e.g. for deviations in the range up to 5 to 10 cm from the base curve, which would represent the creation of a live storage of 7 to 14 billion m^3 or 300 to 600 GWh of energy that cold be shifted in time to optimize use. The future plants downstream from Owen Falls would benefit insofar as they could be designed with an installed capacity for a given plant factor higher than the one without the possibility to regulate the flow. The plants downstream from Lake Kyoga would benefit less directly due to the lake's dampening effect on the flows.

- In a further step, the studies should identify the consequences of the deviations from the "agreed rule" of the environment in the areas around Lake Victoria and along the Nile donwstream from the lake. On the shores of Lake Victoria, the negative effects, if any, should be extremely limited as deviations of 10 cm from a given level are usually well within the annual movement of the lake level. Further, the movements would be

very slow indeed. On the river stretch between Lake Victoria and Lake Kyoga, the effect is likely to be more noticeable, in particular in the area of the shallow Lake Kyoga, where even small variations of the lake level may induce substantial changes in the shoreline and the areas submerged. Further downstream, Lake Albert with its 500 km^2 surface further dampens the variations in the river regime. Therefore, the deviations from the "agreed curve" at the outlet of Lake Victoria are likely to be nearly imperceptible when the White Nile enters southern Sudan, let alone when it exits the swamps of the Sudd further north after having lost about half of its flow to evaporation. As minor as this environmental impact is likely to be, it must nevertheless be assessed.

On the basis of the above results, the studies should set forth a proposal for a set of rules for the utilization of Lake Victoria as a reservoir. These would most likely be based on two or more rule curves creating ranges of Victoria Lake levels within which operation should take place under various sets of circumstances.

The Residential Market in Uganda
Estimating the Number of Potential Electricity Users

Approach

The number of electricity users in Uganda should be that shown in the records of the electric utility, if they are accurate, plus the 3500 owners of photovoltaic devices. There may indeed be some doubt about the records since the UEP has approximately 100,000 residential users on record, 2.7% of all households, while the Household Survey shows that 5.3% of all households use electricity as a source of lighting. An attempt is underway to determine who the actual users are, but the results will not be available for another year. For the purposes of this estimate, it will be assumed that 4% of the households have electricity today. In any case, the problem that this estimate aims to solve is to determine the potential number and consumption of potential users who are not connected to the grid as yet; this can be used to estimate what investments in new facilities can be justified, and whether they can be repaid. In Uganda the bulk of the electricity (57%) is billed to residential users. Therefore this is the category that ought to be given attention in the first place. Most residential users pay for the electricity out of their own funds. This can be a constraint on consumption in a country where over half the population has an income below the poverty level. Other users, such as commercial and industrial enterprises can pass on their energy costs to the customers, and are less price sensitive. The experience of recent years is that users have shown more and more resistance to increased electricity rates. Thus it can be useful to estimate how much a household can afford to pay for electricity, and what factors may affect the number of potential users for the power grid.

The Integrated Household Survey

Many of these factors are either not recorded or not easily measurable. In the case of Uganda, however, the recently completed Uganda National Integrated Household Survey of 1992-93 is a good tool to produce an approximate number for the potential users. The Survey's data on expenditures and dwelling types can help to assess two limiting factors. One is the ability of the household to pay the electricity bills; the other is the proportion of existing dwellings that can be wired safely and physically connected to the overhead conductors of the distribution lines. Both of these factors refer to the conditions as they were at the time of the survey. Incomes will hopefully increase in future, and dwellings may be rebuilt; thus the limits will shift, albeit only slowly. Other important factors that have not been quantified for lack of information, such as location and user confidence. Some dwellings will be located at such a distance from the distribution lines that it would be prohibitively expensive to connect them. Other users may not be able to afford the cost of wiring and connecting the dwelling. Some potential users may even be hard to convince that paying for electricity from the national grid is worth the cost. A proportion of the many self-employed, may not feel sufficiently confident about their income being sufficiently steady to commit the household to the monthly payment of electricity bills. Therefore the percentages estimated below are to be considered as upper limits under present conditions, and not as targets to be aimed for. All in all, this calculation is more an example of the factors that should be taken into account, rather that a methodology for defining them with certainty.

Cost of Electricity for Residential Use

At the electricity rates charged by UEB since July 1993 (see Annex 3.4), the monthly bill for residential users of small quantities of energy would be:

For a usage of 30 kWh/month
(fixed fee Sh1,000 plus 30xSh20=Sh600) USh1,600/mo
(30 kWh of consumption would include typically three light bulbs, a radio, and a fan)
Note that this 20 Sh/kWh rate does not cover the marginal, or even the incremental cost of supply: it is a rate that is cross-subsidized by other categories of users within UEB.

For a usage of 50 kWh/month
(Fixed fee Sh1,000 plus 50xSh70=Sh3500) USh4,500/mo
(50 kWh includes the same appliances as above, plus either a TV or an electric iron).

For a usage of 150 kWh/month
(Fixed fee Sh1,000 plus 150xSh70=Sh10,500) USh11,500/mo
(150 kWh is sufficient for the same appliances as above, plus a small refrigerator).

Cost of Electricity for Small Commercial or Industrial Use

For a usage of 200 kWh/month
(Fixed fee Sh4,000 plus 200xSh115=Sh23,000) USh27,000/mo
(This could cover lights, radio or TV, and a refrigerator or freezer for a small shop).

Household Income

It is generally agreed that, to be affordable, the expenditure for electricity should not exceed 4 to 5% of the household's expenditures or income. The data of the Uganda National Integrated Household Survey of 1992-93 has been used to estimate the number of households for whom the electricity bill would be 5% or less of the total. The numbers (and the percentages of the totals) are reported below for: (i) Uganda as a whole; (ii) the Central region, where approximately 25% of the population live, and (iii) for the city of Kampala, with approximately 5% of the total population of the country. It is immediately apparent that there are wide disparities between the income/ expenditure levels in the capital and in the rest of the country. This is not surprising as it has been estimated that more than half of the population subsists below the poverty level, and that only a small proportion can think about affording electricity.

Monthly expenditure in USh 1,000 by household	Number of Households in 1000s: All of Uganda	Central Region	Kampala City	Affordable Usage/mo.
Between 0 and 50	2,830 (76%)	617 (54%)	44 (22%)	Doubtful
Between 50 and 100	633 (17%)	319 (28%)	71 (36%)	
30 kWh				
Between 100 and 200	190 (5%)	135 (12%)	48 (24%)	50 kWh
above USh200,000/month	77 (2%)	65 (6%)	38 (18%)	150 kWh
Total of all households	3,730 (100%)	1,136 (100%)	199 (100%)	

Quality of Dwelling Construction

In order for a dwelling is to be wired for electricity, and connected to the grid, it must meet some minimum structural and safety requirements. This rules out the traditional mud and pole walls, and calls for cement block, brick or timber construction. A thatched roof is generally not acceptable, while sheet metal or tile roofs are preferred. The percentage of occupied dwellings that would meet minimum requirements for walls and roofs is:

Dwellings of Acceptable Permanent Construction	All of Uganda	Central Region	Kampala City
Percentage of all dwellings	15.4%	31.5%	60.3%

Cost of Access and of Wiring

Before applying for electricity service, a household must consider the investment for access and wiring. While precise data on these costs are not available at this time, they are mentioned because they are substantial outlay, that must be incurred even before the purchase of electric appliances. The dwelling must be provided with housewiring, outlets, lamp sockets, switches, fuses. This should be done by a licensed electrician. and checked by an inspector prior to the installation of a meter. The cost of the materials, meter, the meter box, the overcurrent protection, the service drop (outside wires) plus the installation can easily amount to US$300 equivalent. All of this is paid by the user. In addition to this UEB will ask for a deposit equal to three months consumption.

Number of Potential Users

From these two requirements, that the household be able to pay its monthly bills, and that the dwelling be suitable for connection to the electricity system, it follows that no more that 7% of the total population can afford unsubsidized electricity. This is the percentage of

households that has an income or expenditure level of USh100,000 per month or greater, and that should be able to afford an electricity bill of USh 4,500/month for a usage of 50 kWh.

Another 17% of the households (those between USh 50,000 and USh100,000 per month) could be added if sources could be found to subsidize their consumption. This percentage, however is not to be considered realistic, because the quality of the dwelling would be the next limiting factor. The total number of acceptable dwellings is 15%, including those already connected. In sum, assuming that 3-4% of households is connected at present, the number could double to 7% if the new customers were to pay the full cost. In theory the number could triple or quadruple to 11% of households if it were feasible to let them have electricity below cost, and wire their dwellings for free. Another obstacle to be considered is that 82% of households use kerosene for lighting, and that it is still cheaper, even if it is highly taxed. The cost of two liters of kerosene (USh1,300) would still be less that even the subsidized cost of electricity. Only a small photovoltaic device might compete with kerosene for lighting a small dwelling. In any case, the city of Kampala and the surrounding Central Region are the most promising areas for expanding the usage of electricity from the grid. The rest of the country is only a limited market for the utility.

To move from the percentages to absolute figures, 7% of the 3,730,000 households would amount 261,000 potential users. Since approximately 100,000 of these are already connected to the grid according to UEB. This leaves a maximum of 161,000 as an estimate of the upper limit of the as yet unserved, but potential market at the present level of electricity prices and of income distribution. As the UEB figures are open to question, it is possible that up to another 50,000 users have electricity without appearing on the records. This would reduce the potential market even further.

THE NATIONAL BIOMASS STUDY: PRELIMINARY RESULTS AND ESTIMATES OF BIOMASS SUPPLY

1. The National Biomass Study (NBS) is an inventory of woody biomass and crop residues which is being undertaken by the Ugandan Forestry Department with the support of the Norwegian Forestry Society. The NBS study is one of the most comprehensive biomass studies ever undertaken in any country, and will provide information on land use, woody growing stock by land use and annual yield of crop residues and wood, again by land use categories. Already a technical report has been issued covering phase I of the study, (Forestry Dept. Sept. 1992.) and this gives detailed information for nine regions in Uganda, which were thought to be "biomass stress" regions. These regions cover between 100,000 hectares and 300,000 ha., around nine urban centres, namely, Kabale, Mbarara, Arua, Kampala, Kamuli, Jinja, Kumi, Mbale and Moroto. Together these areas contain 15% of the rural population and 63% of the urban population, yet only occupy 6.5% of the country's land area. Only three areas, Moroto, Kamuli and Kumi, have population densities of one person per hectare or less. The others range from 1.5 persons per ha. in Mbarara to 5 persons per ha. in the Kampala region, which contains the capital.

2. Twelve land types are recognized, including swamp land and open water and the biomass cover for each land type was determined from photo interpretation, ground sampling and field measurements. Sites were revisited to obtain information about annual growth and yield. As an indicator of the productivity of the various categories of land area, Table 1 shows the NBS results in terms of biomass stock per hectare, and yield per hectare. The forests, which include plantations, have the largest growing stock and annual yield per hectare, but because they occupy such a small area, they contribute only a small percentage of total biomass supply. The most important source of wood in the nine sample regions is the arable land with woodlands and bushlands providing about half the yield of arable lands. This is because arable agriculture occupies nearly two thirds of the land, and tress are an integral part of small farms. Bushes and shrubs contribute less than 20% of the growing stock, but they provide over one third of the woody yield, because they are on much shorter rotations. Bush wood is commonly used by rural households, whereas larger dimensional wood is used by industry and charcoal makers. Arable agriculture provides nearly as much crop residues per hectare as it does wood, but much of this is not utilized because wood is preferred. Only grain residues, coffee prunings and husks and sugar cane waste, (bagasse), were included in the assessment of residues, for it was noticed that other forms of residues were hardly used. Also dung is not used as a fuel.

3. The average yield per hectare of biomass is nearly 3 tons per year of which two-thirds are wood and one-third residues. This is normal in areas where the annual rainfall is 1000 mm or more. It was assumed that only half of the crop residues would be available as fuel, because of other uses and environmental or soil fertility considerations.

Similarly about 90% of wood is available as fuel, the other 10% being used for poles, posts and sawnwood etc.

4. The total growing stock on the 1,306,000 hectares of land in the nine regions, was estimated to be 16.5 million tons (air dry) of wood and 1.3 million tons (ad.) of crop residues, excluding papyrus, (another 1.2 million adt). This growing stock produced an annual yield of 2.5 million adt of wood and 1.2 million adt of crop residues.

5. Phase II of the NBS will make estimates for the rest of the country, as well as monitoring sample plots for growth and yield in all areas. In order to obtain an approximate figure of biomass growing stock and yield for Uganda, the per hectare figures, summarized in Table 1 were used and adjusted by an estimated accessibility rate. The estimated annual yield for Uganda is 21 million adt of wood and 5 million adt of residues, as summarized in Table 2.

Table 1: Uganda: National Biomass Study Phase 1
Growing Stock and Yield by Land Use Type
(tons/hecatare)

Land use type	*Area*	*Growing Stock (T/ha)*				*Annual Yield (T/ha)*			
	('000 ha)	*Trees*	*Bush*	*Total Wood*	*Crop Res*	*Trees*	*Bush*	*Total Wood*	*Crop Res*
Planted Hardwoods	8.8	35.6	1.0	36.6	0.1	5.3	0.3	5.6	0.1
Planted Softwoods	1.7	266.4	0.4	266.8	0.0	18.6	0.1	18.7	0.0
Tropical High Forest (THF) nor	13.6	76.8	3.6	80.4	0.0	3.8	1.1	4.9	0.0
THF degraded	3.3	44.0	4.2	48.2	0.5	2.2	1.3	3.5	0.5
(THF average)	16.9	70.4	3.7	74.1	0.1	3.5	1.1	4.6	0.1
Sub-total Forests	27.4	71.4	2.6	74.0	0.1	5.0	0.8	5.8	0.1
Woodlands	46.1	34.4	4.4	38.8	0.6	1.7	1.3	3.0	0.6
Bushlands	195.7	10.0	8.5	18.5	0.1	1.0	2.6	3.6	0.1
Sub-total W&B	241.8	14.7	7.7	22.4	0.2	1.1	2.4	3.5	0.2
Grasslands	94.1	4.0	1.3	5.3	0.0	0.4	0.4	0.8	0.0
Wetlands	61.8	6.1	0.8	6.9	0.0	0.3	0.2	0.5	0.0
(Wetlands Papyrus)	61.8				20.0				20.0
Subsistence Agriculture	841.1	8.4	0.9	9.3	1.2	1.3	0.3	1.6	1.2
Estate Agriculture	22.0	0.0	0.7	0.7	10.7	0.0	0.2	0.2	10.7
Sub-total Agriculture	863.1	8.2	0.9	9.1	1.4	1.3	0.3	1.6	1.4
Urban	18.0	10.4	0.7	11.1	0.2	1.0	0.2	1.2	0.2
Total excluding papyrus	1306.2	10.3	2.2	12.6	1.0	1.2	0.7	1.9	1.0
Total including papyrus	1306.2				1.9				1.9
Water	50.6				1.0				1.0
Grand Total	1356.8								

Table 2 : Uganda: Estimated Growing Stock and Yield of Biomass by Land Use Type (millions tons air dry)
Based on Results of National Biomass Study Phase 1

Land use type	*Area*	*Growing Stock (mill tons air dry)*				*Access*	*Annual Yield (mill tons air dry)*			
	('000 ha)	*Trees*	*Bush*	*otal Wood*	*Crop Res*	*(%)*	*Trees*	*Bush*	*Wood*	*Crop Res*
Planted Hardwoods	36	1.28	0.04	1.32	0.00	100%	0.19	0.01	0.20	0.00
Planted Softwoods	14	3.73	0.01	3.74	0.00	100%	0.26	0.00	0.26	0.00
Tropical High Forest	700	49.28	2.60	51.88	0.07	15%	0.37	0.12	0.49	0.01
Sub-total Forests	750	54.29	2.64	56.93	0.07		0.82	0.13	0.95	0.01
Woodlands	1,400	48.16	6.16	54.32	0.84	30%	0.71	0.55	1.26	0.25
Bushlands	5,500	55.00	46.75	101.75	0.55	30%	1.65	4.29	5.94	0.17
Sub-total W&B	6,900	103.16	52.91	156.07	1.39		2.36	4.84	7.20	0.42
Grasslands	5,000	20.00	6.50	26.50	0.00	40%	0.80	0.80	1.60	0.00
Arable agriculture	4,300	35.20	3.85	39.05	6.20	75%	4.09	0.96	5.04	4.65
Fallow agriculture	2,000	20.00	17.00	37.00	0.20	75%	1.50	3.90	5.40	0.15
Sub-total Agriculture	6,300	55.20	20.85	76.05	6.40		5.59	4.86	10.44	4.80
Wetlands	400	2.44	0.32	2.76	0.00	40%	0.05	0.03	0.08	0.00
Urban areas, etc.	620	6.45	0.43	6.88	0.12	100%	0.62	0.12	0.74	0.12
Total land	19,970	241.54	83.66	325.19	7.99		10.24	10.78	21.02	5.36
Water	3,630				0.00					
Total Area	23,600									

Consumption of Fuelwood in Uganda (000 air-dried tons), 1983-1993

	Household	Commercial	Industrial	for Charcoal	Total Fuelwood
1983	9,683	1,338	525	1,400	12,946
1984	9,954	1,376	499	1,328	13,157
1985	10,223	1,414	473	1,264	13,374
1986	10,522	1,454	473	1,264	13,713
1987	10,814	1,494	497	1,392	14,197
1988	11,115	1,536	548	1,528	14,727
1989	11,432	1,580	602	1,448	15,062
1990	11,751	1,626	638	1,520	15,535
1991	12,068	1,674	691	1,596	16,029
1992	12,400	1,733	780	1,692	16,605
1993	12,710	1,776	800	1,734	17,020
AAG 1983/19	2.8%	2.9%	4.3%	2.2%	2.8%

Notes:

The statistics department assumes that charcoal production has efficiency of 12.5%.

The Uganda: Issues and Options in the Energy Sector study, July 1983, estimated charcoal use in 1983 of 238,000 tons.

The National Biomass Study, 1992, estimated about 400,000 tons charcoal in 1990.

Source: Statistics Department, Ministry of Finance and Planning, Uganda (Budget Background page 76).

UGANDA HOUSEHOLD CONSUMPTION, 1994
(basis of traditional fuels forecast)

	Rural	Rural /a	Urban /b	Kampala	Totals
Pilot Survey Results					
Crop residues (kg/cap/yr)	52	52	12	1	
Collected wood (kg/cap/yr)	522	608	152	42	
Purchased wood (kg/cap/yr)	53	8	122	62	
Charcoal (kg/cap/yr)	16	2	88	190	
Paraffin (litres/cap/yr)	7	7	7	16	
LPG (kg/cap/yr)	0	0	0	1	
Electricity (kWh/cap/yr)	0	0	1	33	
1991 population (Census)		14,782,083	1,115,381	774,241	16,671,705
1994 population estimate c/		15,810,201	1,347,324	935,244	18,092,769
1994 Residential estimates d/					
Crop residues (Tons)		817,229	15,494	1,150	833,874
Collected wood (Tons)		9,605,796	204,295	39,523	9,849,614
Purchased wood (Tons)		125,715	163,902	57,648	347,265
Charcoal (Tons)		37,992	117,972	178,005	333,969
Paraffin (m3)		104,980	8,946	15,085	129,011
LPG (Tons)		0	0	1,356	1,356
Electricity (MWh)		0	1,118	30,592	31,710

a/ Assumes 85% of rural households do not use charcoal and collect all their wood. Per capita collected wood for these households is estimated using sample means for collected + purchase + 3 x charcoal. 15% of rural households are represented by the sample means for woodfuels.

b/ Does not include Kampala.

c/ Rural population growth at 2.2%/yr 1991-1993 and at 2.4%/yr 1993-1994. Urban population growth at 6.5%/yr.

d/ Includes fuel for preparing animal feed, preparing food for sale, brewing, and other uses.

UGANDA TRADITIONAL FUELS CONSUMPTION FORECAST

Total Consumption (residential, commercial, and industrial)												
	Crop residues ('000T)			Collected wood ('000T)			Purchased wood ('000T)			Charcoal ('000T)		
	Rural	Urban	Kampala	Rural	Urban	Kampala	Rural	Urban	Kampala	Rural	Urban	Kampala
1991	917	15	2	10,777	169	33	141	197	64	42	116	176
1992	937	16	2	11,014	180	35	144	209	68	43	123	186
1993	958	17	2	11,257	192	37	147	223	72	44	130	197
1994	981	19	2	11,527	204	40	151	238	77	44	137	207
1995	1,004	20	2	11,804	218	42	154	253	82	45	144	218
1996	1,028	21	3	12,087	232	45	158	269	87	45	152	229
1997	1,049	22	3	12,321	244	47	168	290	94	45	160	241
1998	1,070	24	3	12,560	257	50	179	312	100	46	168	254
1999	1,091	25	3	12,803	270	52	191	335	107	47	178	269
2000	1,113	27	3	13,051	284	55	204	361	115	47	189	286
2001	1,135	29	4	13,303	298	58	217	388	123	48	201	304
2002	1,158	31	4	13,559	313	61	231	418	132	49	214	323
2003	1,181	33	4	13,820	328	63	246	451	142	50	228	344
2004	1,205	35	4	14,085	344	67	262	486	152	51	243	366
2005	1,229	37	5	14,355	360	70	279	524	164	52	258	390
2006	1,254	40	5	14,629	376	73	297	565	176	53	275	415
2007	1,279	42	5	14,908	393	76	317	609	188	54	293	442
2008	1,304	45	6	15,192	409	79	337	658	202	55	312	471
2009	1,330	48	6	15,481	426	82	359	710	217	56	332	501
2010	1,357	51	6	15,774	443	86	383	767	234	58	354	534
2011	1,384	54	7	16,073	460	89	408	829	251	59	377	569
2012	1,412	58	7	16,376	476	92	434	897	270	60	401	606

Forecasts based on average per capita usage from the pilot survey and population growth assumptions.
Improved charcoal stoves reach 25% penetration by 2005 and reduce charcoal consumption by 35% each.
For rural dwellers, fuelwood purchased per capita is assumed to double between 1997 and 2012
to offset an identical absolute decrease in per capita fuelwood collected.
For urban dwellers, fuelwood collected per capita is assumed to decline by 25% between 1997 and 2012
and is offset by an identical absolute increase in per capita fuelwood purchased.

Residential estimates are increased by 20% to account for industrial and non-household commercial uses.
Residential crop residues estimates for Kampala are doubled to account for the use of coffee husks in brick making.
Urban commercial and industrial fuelwood is assumed to be purchased.

UGANDA TRADITIONAL FUELS CONSUMPTION FORECAST

Total Consumption Forecasts: Business as usual

	Crop res ('000T)	Fuelwood Collected ('000T)	Fuelwood Purchased ('000T)	Charcoal ('000T)	Charcoal wood equiv ('000T)	Marketed wood equiv ('000T)	Total Roundwood ('000T)
1991	934	10,979	402	334	2,228	2,630	13,609
1992	955	11,229	422	352	2,349	2,770	14,000
1993	977	11,486	443	370	2,469	2,912	14,398
1994	1,002	11,771	465	388	2,589	3,055	14,825
1995	1,026	12,063	490	406	2,709	3,199	15,262
1996	1,052	12,363	515	425	2,835	3,350	15,714
1997	1,074	12,613	552	446	2,972	3,523	16,136
1998	1,097	12,867	591	469	3,125	3,716	16,583
1999	1,120	13,126	634	494	3,296	3,930	17,055
2000	1,144	13,390	680	523	3,484	4,164	17,553
2001	1,168	13,659	729	553	3,689	4,418	18,076
2002	1,193	13,932	782	586	3,910	4,692	18,624
2003	1,218	14,211	839	622	4,147	4,985	19,197
2004	1,244	14,495	900	660	4,400	5,300	19,795
2005	1,271	14,784	966	700	4,669	5,636	20,420
2006	1,298	15,078	1,038	744	4,957	5,994	21,072
2007	1,326	15,377	1,115	789	5,263	6,377	21,754
2008	1,355	15,681	1,198	838	5,588	6,786	22,467
2009	1,384	15,989	1,287	890	5,935	7,222	23,211
2010	1,414	16,303	1,384	946	6,304	7,687	23,990
2011	1,445	16,621	1,488	1,004	6,696	8,184	24,805
2012	1,477	16,944	1,601	1,067	7,114	8,715	25,658

The efficiency of charcoal conversion using traditional methods is assumed to be 15% (weight basis).

Business as usual:

By 2005, improved charcoal stoves are adopted by 25% of households using charcoal and the average stove reduces charcoal consumption by 35% relative to a traditional sigiri.

COMPARATIVE URBAN COOKING COSTS IN CENTRAL & EASTERN UGANDA 1994

Notes to Table 4.5:

a/ Financial prices for fuelwood, charcoal, and paraffin are mean retail prices from the pilot household energy survey weighted by urban population in Kampala and outside of Kampala in the Central and Eastern regions. The financial price of LPG is based on a retail price of USh 32,000 for and 18kg tank. Since fuelwood and charcoal are provided by an essentially open and informal market without excessive fees, economic costs are assumed to be reflected in their market prices. (Note: this assumption is not valid if wages do not reflect real returns to labor, if diesel fuel, which carries a duty of roughly 40% of the final retail price, constitutes a substantial share of retail woodfuel prices, or if existing stumpage fees and levies are either insufficient to ensure that commons resources are not depleted or are in excess of the public costs of managing these resources.) The economic cost of paraffin is the financial price minus 232 USh/l duty. The economic cost of LPG is the financial price minus 49%, which is the percentage of the petrol pump price attributed to duty. The financial electricity price is the second tier of the existing residential tariff, which was revised in July, 1993 to reflect the economic cost (LRMC) of residential service. Residential customers pay a monthly connection fee of USh 1,000 plus 20 USh/kWh for the first 30 kWh/month, 70 USh/kWh for 31 -200 kWh/month, and 100 USh/kWh for monthly consumption beyond 200 kWh.

b/ Financial stove costs are Kampala retail prices amortized at 12%. Most fuelwood is consumed in three-stone stoves, even in urban areas. The average cost of an improved wood stove is USh 5,000 and it must be replaced yearly. **A traditional** Sigiri charcoal stove costs USh 2,500 and must be replaced each year, while an improved charcoal stove costs roughly USh 10,000 and lasts on average 1.5 years. Efficiencies of traditional and improved wood and charcoal stoves are from the HEPP cooking tests. The average kerosene stove is an imported wick stove that costs USh 15,000 and last 3 years. LPG and electric cooking appliances are also imported. An 18 kg LPG cylinder and single burner stove cost about USh 85,000 and last 5 years. A simple electric hot plate costs roughly USh 15,000 and lasts 2 years. With no foreign exchange premium, financial stove costs reflect economic costs even for imported stoves.

c/ Amortized stove costs are added to fuel costs on the basis of weighted mean cooking energy use of urban households in Central and Eastern Uganda from the pilot household energy survey (635 utilized MJ/hh/month).

d/ Payback periods for improved wood stoves and charcoal stoves are just over one month and under 4 months, respectively. Even at a 50% financial discount rate (which is a better model of actual household purchasing decisions), improved charcoal stoves pay back their initial costs in fuel cost savings within 4 months.

ECONOMIC EVALUATION OF IMPROVED STOVE AND CHARCOAL KILN PROGRAMS

Year	Stove Program Costs US$	Additional Improved Charcoal Stoves #	Additional Cost ($7.5/stove) (1 yr stove life) US$	Urban Wood Stoves #	Cost ($5/stove) (1 yr stove life) US$	Charcoal Savings Tons	Retail Value ($100/Tons) US$	Wood Savings Tons	Economic Value ($67/T purch.) ($17/T collects) US$	Net Economic Benefits US$
1995	550,000	0	0	364	1,820	0	0	322	14,522	-537,297
1996	165,000	420	3,153	702	3,508	117	11,731	621	27,993	-131,937
1997	180,000	5,813	43,599	1,345	6,725	1,622	162,201	1,191	53,960	-14,162
1998	200,000	22,473	168,545	2,554	12,772	6,270	627,047	2,262	103,046	348,777
1999	220,000	46,330	347,475	4,771	23,854	12,927	1,292,734	4,225	193,581	894,986
2000	0	74,640	559,797	8,665	43,327	20,827	2,082,659	7,673	353,734	1,833,269
2001	0	104,542	784,068	15,060	75,298	29,170	2,917,043	13,336	618,601	2,676 278
2002	0	133,918	1,004,383	24,552	122,759	37,367	3,736,716	21,741	1,015,067	3,624 641
										63%

Stove program costs are from HEPP, 1990.

The number of improved stove are derived from diffusion rates presented in Figure 1, the number of stoves per household from the pilot survey (on average, real and urban homes have 1.85 and 0.6 wood stoves and 0.02 and 1 charcoal stove), and population growth assumptions. The number of stoves per household and average household size of people/HH is assumed to remain constant over the period. In addition, fuel usage figures from the pilot survey were combined with fuel savings results from the HEPP cooking test to arrive a the average fuel savings that could be expected from each improved stove. Pilot survey households that use charcoal for cooking use 800 kg/year, on average. The HEPP cooking tests show that improved charcoal stoves use only 65% of the charcoal used in a traditional sigiri under normal conditions. Under the assumption that households that adopt improved stoves will use only one improved stove, each stove can be expected to save 280 kg of charcoal annually. Similarly, households that cook with would commonly use a three-stone fireplace and consume, on average, 2 tons of wood annually. HEPP field tests showed that improved stoves can cut wood use nearly in half. Hence, the average wood using household that switches from a three-stone fire to an improved wood stove can be expected to save nearly 900 kg of wood annually.

The economic value of saved charcoal and traded wood is reflected in market prices and the economic value of collected wood is evaluated at 2S% of the retail price.

ECONOMIC EVALUATION OF IMPROVED STOVE AND CHARCOAL KILN PROGRAMS

Year	Rural NGO Component Cost US$	Rural Wood Stoves #	Cost ($5/stove) (1 yr stove life) US$	Wood Savings Tons	Economic Value ($67/T parch.) ($17/T collect.) US$	Net Economic Benefits US$
1995	300,000	7,315	36,575	6,480	112,745	-223,830
1996	400,000	13,558	67,789	12,010	208,964	-258,825
1997	500,000	24,896	124,478	22,053	384,345	-240,133
1998	500,000	45,280	226,400	40,111	700,247	-26,153
1999	500,000	80,998	404,988	71,751	1,254,862	349,874
2000	0	140,904	704,521	124,818	2,187,056	1,482,535
2001	0	234,529	1,172,644	207,75	3,647,357	2,474,713
2002	0	366,199	1,830,993	324,391	5,706,643	3,875,650
						60%

Stove program costs are recurrent expenditures to fund the activities of NGOs responsible for dissemination of improved wood stoves in rural areas.

Year	Charcoal Kilns Program Cost US$	Charcoalers Improved Kilns #	Cost ($100/kiln) (1 year life) US$	Increased Charcoal Yield Tons	Charcoalers' Selling Price $33/Ton US$	Net Benefits US$	Urban & Rural Stoves & Kilns Net Benefits US$
1995	250.000	11	1,105	552	18,411	-232,694	-993,821
1996	50.000	21	2,092	1,046	34,870	-17,222	-407,985
1997	55.000	39	3,948	1,974	65,799	6,851	-247,445
1998	60.000	74	7,402	3,701	123,373	55,971	378,594
1999	65.000	137	13,692	6,846	228,203	149,511	1,394,370
2000	0	247	24,687	12,343	411,445	386,758	3,702,561
2001	0	427	42,653	21,327	710,890	668,236	5,819,227
2002	0	692	69,204	34,602	1,153,394	1,084,190	8,584,481
						47%	60%

Charcoal kiln program costs are from HEPP, 1990.

These calculations assume that charcoalers who adopt improved methods produce 50 tons/year on average and are able to double their yield for a given wood input.

Charcoaler's selling price averages about 1/3 of the final retail charcoal price (woodfuel transport study of the national Biomass Study, Phase 1, 1992).

REPORT OF THE: RAPPORTEUR GENERAL

Workshop on Energy Sector Assessment and Power Sector Reform Options for Uganda
August 19 - 20, 1996

GRAND IMPERIAL HOTEL
Kampala, Uganda

Prepared by
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1. OVERVIEW OF THE WORKSHOP

1.1 Objectives

A joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) exercise for the assessment of key issues and options in the energy sector was launched in February 1994. The exercise engaged the services of World Bank staff, international consultants, and an interdisciplinary team of local experts drawn from various Government departments as well as the private sector. In March 1996 a report was produced. The purpose of the workshop was to make a presentation of the ESMAP report.

The workshop would also benefit the on-going process for power sector reform. The preliminary findings of the power sector reform exercise to cover the proposed legislative and regulatory framework were presented.

This report gives highlights of the presentations, discussions and recommendations made at the workshop. At the end of the workshop, it was the opinion of the participants that arising out of the recommendations, a clear energy policy should be developed.

1.2 Participants

Participants were drawn from the following institutions:

- Ministry of Natural Resources
- Ministry of Finance
- Ministry of Planning and Economic Development
- Ministry of Justice and Constitutional Affairs
- Uganda Electricity Board
- Uganda Investment Authority
- National Environment Management Authority
- Makerere University
- Enterprise Development Project (Ministry of Finance)
- Uganda Small Scale Industries Association
- Shell (U) Ltd
- Nile Independent Power
- Kilembe Mines Ltd
- Pakwach Power Plant Ltd
- Uganda Renewable Energy Association
- Solar Energy for Africa
- The World Bank
- United Nations Development Programme (UNDP)

- Hunton and Williams, USA
- African Regional Energy Policy Research Network
- Standard Bank, UK
- Commonwealth Development Corporation
- British High Commission
- European Investment Bank
- Seeboard International Limited, UK
- Gibb East Africa Ltd
- Midlands Power International, UK
- Ethiopian Energy Studies and Research Centre
- Zimbabwe Electricity Supply Authority
- Uganda Fish Development Association
- Environment Conservation Protection and Awareness Agency

A list of participants is given in Appendix 1.

1.3 Mode of Operation

The workshop was opened by Hon. Gerald Ssendaula, Minister of Natural Resources. Presentations followed by panel discussions were made on the issues, findings and recommendations on: the petroleum, renewable and traditional energy, and power sub-sectors, and the proposed power sector legal framework.

The workshop was closed by Hon. Mathew Rukikaire, Minister of State for Finance (in-charge of privatization). A copy of the workshop programme is given as appendix 2.

2. PETROLEUM SUB-SECTOR

The ESMAP findings, issues and recommendations on the Petroleum sub-sector were presented by Mr. Mangesh Hoskote of the World Bank.

2.1 Major Issues

2.1.1 *Supply Strategy*

Of the three supply routes considered, the ESMAP mission found the Kenyan route, using the pipeline to Kisumu and then barges to Port Bell, least-cost. The workshop was informed that Government will soon embark on the investigation of an alternative supply route, extending the pipeline from Eldoret in Kenya to Kampala.

2.1.2 *Regulatory Measures*

It was observed that no direct impact on the market had been realized as a result of price liberalization. The ESMAP report highlighted the issue of environmental pollution, problems associated with transportation and use of petroleum products. The quality of the products and market behavior were noted as key issues to be monitored by the Ministry of Natural Resources.

2.1.3 *Management of Government Strategic Stocks*

While the ESMAP mission recommended that the strategic storage tanks should be leased to a private oil company, the consensus was that the strategic stocks were of such importance to Government's security that they cannot be entrusted with a private foreign company.

2.1.4 *Illegal Imports*

The workshop observed that the illegal imports are due to the differential tax regimes in the region. The cost of petroleum products in Uganda are about twice the cost in Kenya and Tanzania due to Uganda's high taxes.

2.1.5 *Ethanol Blending*

Discussions centered on the high cost of ethanol production relative to the landed cost of petrol and the problem ethanol had got into in countries where it had been introduced, namely Brazil, Kenya, Zimbabwe and Malawi.

2.1.6 *Environmental Management*

Environmental issues dealt with potential oil spills on Lake Victoria, availability of spills response kits, and interceptors for containing oil at service stations.

2.1.7 *Oil Exploration*

At the level of exploration reached so far, and the indicators available, it was the consensus that the exercise should be a high government priority. There should be no fear of economic viability as compared to imports. If commercial quantities exist, investors would automatically put in their money.

2.1.8 *Demand Side Management*

It was observed that the ESMAP assessment was supply-oriented, with negligible mention of demand side management. In the case of the petroleum sub-sector, it was necessary to improve the efficiency of fuel use, especially in the transport sub-sector in order to reduce capital investment costs.

2.2 Recommendations

On the supply strategy, it was recommended that a risk analysis and an environmental impact assessment of using each of the optional (not necessarily the least-cost) route that would serve national interests best.

On regulatory framework, the recommendations were in line with those proposed by the ESMAP mission, i.e. Government should:

- implement price and quality monitoring systems,
- investigate legal instruments for monitoring systems;
- incorporate environmental compliance measures in the regulatory activities.

For the government strategic stocks, it was recommended that the government should manage these stocks:

- capacity in government should be built in order to manage the stocks professionally; and
- there is need to urgently address issues of safety and maintenance of the strategic storage tanks.

On illegal imports, a regional attempt should be made to harmonize the tax regimes.

For ethanol, sugar industries should be encouraged to produce ethanol for the export market like in Kenya with an option to turn it into automotive fuel if and when the situation warrants it.

NEMA should establish a programmatic linkage with the Department of Energy and the oil companies.

On oil exploration, government efforts to mobilize funds to go the extra distance of seismic surveys should continue. In particular, the World Bank was requested to provide at least US$3 million to accomplish this task.

To accomplish demand-side management in the transport sub-sector, studies should be undertaken to lay the ground for sub-sector reforms aimed at making it more efficient.

3. RENEWABLE AND TRADITIONAL ENERGY SUB-SECTOR

Presented by Robert Van der Plas of the World Bank, Washington DC.

3.1 Major Issues

Biomass energy is the most used source of energy and it is used inefficiently. Liquid fuels and gas are too expensive for the rural population to afford and it will take quite sometime before we see free biomass being substituted for by these alternatives.

Conversion of wood to charcoal is inefficient (estimated at 12%). In addition to extraction of commercial timber and clearing for agriculture, charcoaling poses a serious danger to the environment and no action has been taken to improve charcoaling efficiency.

Prices for round wood and for paraffin and LPG are rated high by world standards while low for charcoal.

Most rural families do not have access to modern sources of energy and yet there has not been any systematic effort to address this issue.

Improved stoves have not made an impact, market penetration in the urban areas is estimated at 15% of the households.

It was also realized that Macro-economic policies do not cater for rural people in the energy sector and that funding for traditional and renewable energy programmes is not readily available.

3.2 Panel Discussions

During panel discussions several issues were raised and discussed in depth by the members of the panel, some highlights are listed below:

3.2.1 *The Report*

It was felt that the ESMAP report did not focus on demand, policy, course of action, human centered energy issues and the ecology.

3.2.2 *Charcoal*

Improvement of charcoal production efficiency has been stifled by the legal status of charcoalers and the land tenure system. Charcoalers either operate illegally on gazetted forest land or squatters. They are highly mobile and operate individually. So

it is a problem to organize them into groups for training. However, it was proposed that in the event of improvement the initial attempts should be to improve on the traditional technologies because modern technologies are expensive and beyond the means of poor charcoalers.

3.2.3 *Cookstoves*

Cookstoves programmes need more policy and financial support. It was noted that institutional stoves are penetrating the market faster than the household sector. Finally many stove programs have failed because they were supply rather than demand driven.

3.2.4 *Biogas*

Opinions were divergent and varied but the general consensus was that this program should be left to the private sector while government can continue extending technical assistance. It was suggested that when selecting biogas intervention the socio-cultural aspects must be given due consideration.

3.2.5 *Rural Electrification*

It was observed that the ESMAP Report did not identify the problems hampering this activity. However it came out that one of the major constraints to rural electrification was the settlement pattern where homesteads are scattered over the country side, rather than being clustered as villages.

3.2.6 *Solar*

It would be almost impossible to extend the grid to each homestead. It was again suggested that solar photovoltaics for rural electrification could be marketed by established utilities like UEB. Solar water heaters were suggested as one way reducing peak loads. Solar cooking was found to be most practicable in population concentration areas such a refugee camps. Many were of the view that solar technologies would be better disseminated through the private sector.

3.2.7 *Wind*

It was suggested that wind pumps should be encouraged for agricultural purposes, in schools and communal water pumping. The potential for wind technology for rural application was viewed to be very high. Wind water pumps have been constructed in Karamoja although some have not performed well because of poor maintenance.

3.2.8 *Briquettes*

It was observed that the report does not mention briqueting technology. Though known to be more expensive than wood charcoal, the amounts of agrowaste are enormous and should be put to use in order to save on our forest resource base. However, it was also noted that briqueting has both marketing and transportation constraints. In order to successfully undertake a briqueting program technology options should be carefully chosen and suitability of the raw materials established.

3.2.9 *Fuel Substitution*

It was observed that fuel substitution to more modern sources of energy in the traditional rural set-up is not possible for the time being because of the poverty existing in the country and lack of information, to some extent. Other alternatives such as briquettes were found to be more costly than charcoal and/or wood. The technology has not done particularly well in many countries.

Fuel substitution in urban areas depends on improved standards of living, and petroleum companies or utilities should be interested in capturing this demand segment.

3.2.10 *Technology Dissemination*

A very important observation was that projects which target energy use for industrial purposes rather than social purposes have tended to be more successful. Again projects which are piggy-backed onto already existing ones which already have an infrastructure have also performed commendably well.

3.2.11 *Financial Support*

Concern was expressed about the non-existence of financial arrangements to assist the rural poor to have access to modern energies, renewables. Subsidies and restructuring of taxation in favor of the poor were suggested.

3.2.12 *Environment*

Many issues concerning the environment were discussed and it came out that gathering of firewood is not an immediate danger to the environment; nevertheless it will be in the long term as population increases. Another major activity that poses danger is poor management of free resources like in wasteful harvesting methods. It was also noted that sustainability of biomass resources should not be taken for granted. Finally matters concerning education and a wareness raising were discussed.

3.3 Recommendations

3.3.1. *Charcoal Production Efficiency*

Improvement of charcoaling efficiency in traditional charcoal production, initially should focus on the improvement of the local (traditional) practices because the status of the rural based charcoaler would not allow heavy investment in modern technologies. Moreover examples elsewhere have shown that these kilns can be made efficient. However, experience in Uganda shows that streamlining the operations of this sector will have to grapple first with the problems of land tenure and illegal felling of trees in forest reserves.

3.3.2 *Cookstove*

Improvement needs more policy support. Quality control measures should be instituted.

3.3.3 *Biogas*

There is a niche for biogas technology and those with the resource could be encouraged to invest in biogas. The Ministry of Natural Resources should provide technical assistance to the private sector to make the technology sustainable. Such technical assistance could include training, awareness, publicity and technology transfer.

3.3.4 *Fuel Substitution*

(a) Government should consider looking into methods to promote LPG to replace woodfuel.

(b) Peak demand for electricity should be reduced by promoting solar water heaters in urban households and institutions.

(c) Government should promote local production of equipment for fuel substitution, e.g., gas stoves and solar water heaters, in order to make the technology cheaper.

(d) Feasibility of production of densified biomass briquettes to substitute for fuel wood in industries, institutions and commercial enterprises should be looked into.

3.3.5 *Education and Awareness Raising*

It was recommended that information dissemination was important for all programs and projects in this sector.

3.3.6 All renewable energy technologies have niches that they can satisfy. These niches should be identified and promoted. In particular solar and wind power have great potential for rural electrification. Solar and wind power development should be undertaken with active participation of the private sector, especially in commercialization. Government will help in facilitation, e.g. policy, mobilization of funds, capacity building, etc.

3.3.7 Niches for solar, wind and micro-hydro electrification can be identified by carrying out a rural electrification study based on demand availability for a particular resource. Then an investment program should be designed.

3.3.8 Utilities such as UEB, can be effective in promoting solar PV for rural electrification and Solar water heaters to reduce peak demand. Solar Water Heaters can be promoted as part of a housing package e.g. by the National Housing Construction Company.

3.3.9 Solar Cookers should be promoted for institutional use especially in wood deficit areas, e.g. refugee camps.

3.3.10 The most effective method of rural renewable energy projects is to piggy back them on already existing programs.

3.3.11 *Environment*

Although there is no immediate threat to the environment by wood gatherers it was noted that whether localized or not, with growing population and increased demand for firewood they remain a threat to the environment, in the long term. Hence it was recommended that several interventions on both demand and supply sides be undertaken.

3.3.12 *Pricing of Biomass Fuels*

(a) A study to look at the impact of taxation especially on the poor urban population, to reflect the true value of biomass fuels should be undertaken.

(b) Biomass fuel producers could grow their own fuel wood or purchase from farmers in order to depict the real value of woodfuels.

4. POWER SUB-SECTOR

A paper on the issues, findings and recommendations made by the ESMAP team was presented by Ms. Karen Rasmussen of the World Bank.

4.1 **Major Issues Raised On The Power Sub-Sector**

It was noted with concern that the country is currently experiencing a critical shortfall in electric power supply which has resulted from the rapid economic growth registered owing to the stability enjoyed in the country. Due to this shortfall in power supply, economic growth is being retarded.

The performance of the sole utility, UEB, is poor resulting into serious cashflow constraints.

Modest intervention measures effected by UEB since November 1994 were noted. These include the following:

- completion of physical re-registration of Kampala customers
- billing 93% of Kampala customers monthly,
- improvement in monthly cash collection,
- bills hand delivered in Kampala,
- re-registration of upcountry customers under way.

Although the existing electricity law permits private participation in the power sector, UEB currently enjoys a monopoly status and plays a multiple role of owning, operating as well as regulating the sector. There is a need to remove barriers to free entry into the sector and to promote efficiency.

Owing to the fact that only 5% of the population has access to electricity and that conventional approaches to electrify rural areas far from the grid, are not economically feasible, a need to extend services to rural areas using non-conventional methods was identified.

Options for changing the way UEB conducts business were outlined, namely:

- Performance contracts: arranged with performance targets, both physical and financial.
- Management contracts: Privatization of UEB's Non-core activities or, privatization of a portion or all of UEB.

The merits and demerits of either option were outlined in the report.

The need for private sector participation for system development and extending electrification was identified. The private sector can participate in:

- decentralized power systems to help serve un-electrified rural and peri-urban areas not connected to the grid.
- Independent Power Production Projects (IPPs) either alone or with public utilities to finance, construct, own and operate generating plants.

4.2 **Panel Discussions And Contributions By Participants**

Discussions of panelists and participants revealed the following salient issues:

- the most urgent issue is to have a short-term solution to the power blackouts,
- load-shedding is mainly a result of a deficit in power supply, brought about by a sudden leap in demand due to expansion in economic activities. This should not be attributed to UEB's inefficiency,
- if no intervention measures are effected, the "drag" on GDP is likely to be 2% valued at more than $300 million each year in loss of output by the year 2000.
- about $1400 million is required to be invested in the power sector and this can only be attained by both private and public participation,
- UEB is an organization with a value well in excess of $2000 million on an asset's replacement basis, and has a highly qualified and experienced human resource base. Although inefficiency may be prevalent throughout the organization and substantial improvement is necessary to bring about meaningful economies, it would be heinous for the Government to dispose of such valuable utility enterprise.
- a need for Government to consider the privatization of UEB very cautiously so as to maximize the value of UEB to Uganda was recognized.
- a danger that the assets could be frittered away at minimal value without assurance of what might replace UEB was also recognized.
- a "fast-track" policy involving close cooperation between the public and private sectors was recognized as a means of addressing the situation.
- it was recognized that power supply is an infrastructure from which Government cannot divorce herself. Rural electrification is a venture which cannot be left entirely in the hands of the private sector.

- a need to address demand-side management in the power sector was recognized. The use of inefficient domestic appliances and industrial machinery contribute considerably to the peak power demand.

- end-use oriented strategies would provide energy sector decision makers in Uganda the opportunity to reduce the high capital and investment requirements associated with a purely supply - side approach.

- private investors should also explore the area of investments in the manufacture of electrical appliances.

- Zimbabwe during 1991/92, experienced a drop of about 15.4% in supply availability which forced the utility, ZESA, to introduce a combination of load-shedding and tariff-based rationing system. UEB can borrow a leaf from the Zimbabwean experience.

- short-term measures to reduce the losses need to be instituted. These include:

  - a metering audit program, disconnection of illegal connections and putting prohibitive fines to discourage such practices, introduction of selective statistical metering to determine the extent of losses by comparative analysis with known data and investigating anomalies.
  - to improve revenue collections, load limiters with the design of an appropriate tariff can be installed, pre-payment meters should also be introduced.

4.3 Recommendations

The following recommendations on the power sector were made:

- An immediate solution to the power shortage should be found. Arrangements for negotiation for construction of a thermal generation plant should be accelerated.

- Fast - track policies must be put in place to address the current load-shedding by facilitating construction of additional capacity to meet present and future load demand. There should be close cooperation between the private and public sectors.

- Outright dismantling of UEB may create a vacuum because:

  - It won't solve the power supply problem.
  - Complete new management may not cope with the challenges UEB faces which are unique to Uganda.

- UEB should divest non-core activities like the treatment of poles, security, housing and public relations.
- UEB should be restructured into a profitable modern company to meet the challenges of the future.
- Training and retraining of staff should be effected to enhance capacity in the utility.
- Competition and free entry of private investors into the power sector must be encouraged mainly to address the power supply problems.
- A stepwise process should be taken for involving the private sector.
- There is a need for a clear policy on private sector participation and a transparent legislative and regulatory framework.
- Partnerships between the public and private sectors should be encouraged.
- It was recommended that Government should design a rural electrification strategy. This activity should not be left to the private sector. The strategy should include innovate grid extension, decentralized power systems including use of renewables mainly solar, wind and micro-hydro systems.
- Demand-side management should be undertaken to minimize the necessity for heavy investment in the power sector. Innovations like use of pre-payment meters and load limiters should be effected for the benefits of both the utility and the consumers.

5. PROPOSED POWER SECTOR LEGISLATIVE AND REGULATORY FRAMEWORK

Presenter: Mr. Fred A. Kabagambe-Kaliisa
Director for Energy and Mineral Development
Ministry of Natural Resources

5.1 Major Issues Highlighted

Under the existing law, Uganda Electricity Board is "owner", "operator" and "regulator".

There is need to put in place a new legislation to address government's policy direction/strategic plan.

The main focal points in government's strategic plan are:

- enhancing capital formulation for the power sector outside government;
- improving efficiency of the power sector;
- enabling new private generation;
- rationalize prices and social subsidies while maintaining certain socially desirable policies e.g. rural electrification and low income "lifeline rates".
-

The main features of the new law would be:

- redefining the role of UEB;
- redefining the role of the Ministry;
- establishing a transparent power sector regulatory framework;
- instituting a suitable funding mechanism for rural electrification;
- flexibility so as to permit a number of sector structures and remain valid as the sector develops over time;
- the cost of running the regulatory framework should be minimized so that it cannot constrain the development of the sector.

5.2 **Panel Discussions and Recommendations**

Private investors and lenders are interested in the clarity and clearness of policy coherence in intra and interministerial policy.

The integrity of the personnel on the regulatory body is of crucial importance.

The regulatory body should be seen to be independent from political influence.

The investors and lenders would be particularly interested in how the licensing system relates to the entire project cycle. For example, what would cause license revocation and what would be the recourse to the investor in case of unfair revocation.

The credibility of UEB as a commercially viable body is of crucial importance. This relates to the economic risk, political risk and the closely related currency convertibility risk. Exports of power encourage earnings of foreign exchange which is often attractive to lenders.

Big industrial users under a special payment arrangement would be preferred by investors and lenders.

The new electricity law would have to be harmonized with other laws land and water laws.

The law should provide for transparent transfer of assets in the event of termination or expiry of licences or concessions.

UEB should be corporatised in a way that allows share holding opened up and allowing share transfer without restriction.

In order to minimize costs, two options for structuring the regulatory framework were considered:

- a part time regulatory board with a secretariat in the Energy Department to be responsible for regulation of the electricity sector only;
- a full time multi-sectoral regulatory agency responsible for regulation of electricity and other utilities like telecoms and water.

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WORKSHOP PROGRAMME

Day 1, Morning

8.00 - 9.00 Registration of Participants

9.00 - 9.15 Welcome Remarks
- F.A Kabagambe-Kaliisa,
  Director, Energy and Mineral Development/
  Workshop Chairman.

9.15 - 9.45 Workshop Objectives and Mode of Presentation
- Ben Z. Dramadri, Permanent Secretary,
  Ministry of Natural Resources

9.45-10.00 Opening Speech
- Hon. Gerald M. Ssendaula,
  Minister of Natural Resources

Rapporteur General: G.R. Turyahikayo
Commissioner, Energy Department

10.00-10.30 Refreshment Break

10.30-11.15 ESMAP Energy Assessment: Issues, Findings and Recommendations
FOCUS on Petroleum Sub-sector

Presenter: Mangesh Hoskote
The World Bank

11.15-1.00 Panel Discussions:
Moderator: B. Z. Dramadri
Permanent Secretary
Ministry of Natural Resources

Panelists: B.J. Twodo, Energy Department
J.R.M. Kasibante, Private Sector
Stephen Karekezi, African Regional Energy Policy
Research Network (AFREPREN)

Rapporteur: Patrick Huhumuza,
Energy Department

1.00 - 2.30	Lunch

2.30 - 3.15 ESMAP Energy Assessment: Issues, Findings and Recommendations
FOCUS on Renewable and Traditional Energy

Presenter: Robert van der Plas
The World Bank

3.15 - 4.00 **Panel Discussion** (Part I)

Moderator: F. A. Kabagambe-Kaliisa,
Director
Energy and Minerals.

Panelists: G.R. Turyahikayo,
Commissioner
Energy Department

Patience Turyareeba,
Private Sector

Steven Karekezi,
African Regional Energy Policy Research Network
(AFREPREN)

Lemma Eshetu,
African Regional Energy Policy Research Network
(AFREPREN)

Rapporteur: Arsen Hbonye
Energy Department

4.00 - 4.30	Refreshment Break

4.30 - 5.30 Panel discussion on Renewable and Traditional Energy (Part II)

Panelists as in Part I

Close of Day 1

Day 2 Morning

9.00 - 9.30 ESMAP Energy Assessment Issues, Findings and Recommendations FOCUS on Power Sub-Sector

Presenter: Karen Rasmussen
The World Bank

Rapporteur: Paul Mubiru
Department of Energy

9.30- 10.15 Proposed Power Sector Legal Framework

Presenter: Fred Kabagambe-Kaliisa,
Director, Energy and Minerals

Rapporteur: Deo Nkunzingoma
Uganda Electricity Board

10.15 - 10.45	Refreshment Break

10.45 - 12.30 Institutional Options to Improve Efficiency in the Power Sector

Moderator: Mangesh Hoskote
The World Bank

Panelists: George Rubagumya
Executive Director
Uganda Investment Authority

Leonard Muganwa
Executive Director
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Simon D'Ujanga
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John Beardsworth
Hunton and Williams
I. Dube
African Regional Energy Policy Research Network
(AFREPREN)

Mitin Madhvani
Director
Nile Independent Power

Rapporteur: S.E. Hatanga
Department of Energy

12.30 - 2.00 Lunch

2.00 - 3.30: Adequacy of Proposed Legal Framework – Investors' and Lenders' Perspective

Moderator: John Beardsworth
Partner
Hunton & Williams

Panelists: N. Howard
Manager, Standard Bank

James Allen Schmidt
Counsel
Private Power and Regulatory Reform, Legal Department,
The World Bank

Leonard Muganwa,
Executive Director
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Ministry of Finance

Charles Kabagambe,
Board Secretary
Uganda Electricity Board

Rapporteur: Herbert M. Dusabe
Solicitor General's office

3.30 - 4.00	Refreshment Break

CLOSURE OF MAIN WORKSHOP

Moderator: Ben Z. Dramadri
Permanent Secretary
Ministry of Natural Resources

4.00 - 4.30: Presentation of the Report of the Rapporteur General

4.30 - 4.45: Clarifications and Comments

4.45 - 5.30: Closing Remarks by Hon. Mathew Rukikaire, Minister of State for Finance
(Privatisation) - Sector Reform and Divestiture: Priorities and Perspectives

Close of Day 2

Joint UNDP/World Bank

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF REPORTS ON COMPLETED ACTIVITIES

Region/Country	*Activity/Report Title*	*Date*	*Number*
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English)	05/89--	
	Francophone Household Energy Workshop (French)	08/89	103/89
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English)	03/90	--
	Symposium on Power Sector Reform and Efficiency Improvement in Sub-Saharan Africa (English)	06/96	182/96
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	--
	Urban Household Energy Strategy Study (English)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (English)	01/84	012/84
	Status Report (English and French)	02/84	011/84
	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Central African Republic	Energy Assessement (French)	08/92	9898-CAR
Chad	Elements of Strategy for Urban Household Energy The Case of N'djamena (French)	12/93	160/94
Comoros	Energy Assessment (English and French)	01/88	7104-COM
Congo	Energy Assessment (English)	01/88	6420-COB
	Power Development Plan (English and French)	03/90	106/90
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (English)	12/87	--
	Power Sector Efficiency Study (French)	02/92	140/91
	Project of Energy Efficiency in Buildings (English)	09/95	175/95

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Ethiopia	Energy Assessment (English)	07/84	4741-ET
	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	--
	Energy Assessment (English)	02/96	179/96
Gabon	Energy Assessment (English)	07/88	6915-GA
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85
Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
	Industrial Energy Efficiency (English)	11/92	148/92
Guinea	Energy Assessment (English)	11/86	6137-GUI
	Household Energy Strategy (English and French)	01/94	163/94
Guinea-Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English & Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800-KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English)	02/87	--
	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English)	11/87	--
	Power Loss Reduction Study (English)	09/96	186/96
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
	Power System Efficiency Study (English and French)	12/87	075/87
	Environmental Impact of Woodfuels (French)	10/95	176/95
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83
	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87

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Mauritius	Bagasse Power Potential (English)	10/87	077/87
	Energy Sector Review (English)	12/94	3643-MAS
Morocco	Energy Sector Institutional Development Study (English and French)	07/95	173/95
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
	Electricity Tariffs Study (English)	06/96	181/96
Namibia	Energy Assessment (English)	03/93	11320-NAM
Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
	Energy Assessment (English)	07/93	11672-UNI
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Rwanda	Energy Assessment (English)	06/82	3779-RW
	Energy Assessment (English and French)	07/91	8017-RW
	Status Report (English and French)	05/84	017/84
	Improved Charcoal Cookstove Strategy (English and French)	08/86	059/86
	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADC	SADC Regional Power Interconnection Study, Vol. I-IV (English)	12/93	--
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	--
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84
	Industrial Energy Conservation Study (English)	05/85	037/85
	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
	Industrial Energy Conservation Program (English)	05/94	165/94
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84
	Wood Energy/Forestry Feasibility (English)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	--

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Tanzania	Industrial Energy Efficiency Technical Assistance (English)	08/90	122/90
Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86
Togo	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English)	03/86	053/86
	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English)	03/89	UNDP Terminal Report
	Energy Assessment (English)	12/96	193/96
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
Zambia	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85
	Petroleum Management Assistance (English)	12/89	109/89
	Power Sector Management Institution Building (English)	09/89	--
	Charcoal Utilization Prefeasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM
	Energy Efficiency Technical Assistance Project: Strategic Framework for a National Energy Efficiency Improvement Program (English)	04/94	--
	Capacity Building for the National Energy Efficiency Improvement Programme (NEEIP) (English)	12/94	--
	EAST ASIA AND PACIFIC (EAP)		
Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	--
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
	Strategic Options for Power Sector Reform in China (English)	07/93	156/93
	Energy Efficiency and Pollution Control in Township and Village Enterprises (TVE) Industry (English)	11/94	168/94
	Energy for Rural Development in China: An Assessment Based on a Joint Chinese/ESMAP Study in Six Counties (English)	06/96	183/96
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86

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Indonesia	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Energy Strategy Paper (English)	--	--
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	--
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979/SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
Western Samoa	Energy Assessment (English)	06/85	5497-WSO
	SOUTH ASIA (SAS)		
Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Prefeasibility Study (English)	12/88	
India	Opportunities for Commercialization of Nonconventional Energy Systems (English)	11/88	091/88

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India	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92
	Power Sector Reform Seminar (English)	04/94	166/94
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84Nepal
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
	National Household Energy Survey and Strategy Fomulation Study: Project Terminal Report (English)	03/94	--
	Managing the Energy Transition (English)	10/94	--
	Lighting Efficiency Improvement Program Phase 1: Commercial Buildings Five Year Plan (English)	10/94	--
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86
	EUROPE AND CENTRAL ASIA (ECA)		
Bulgaria	Natural Gas Policies and Issues (English)	10/96	188/96
Eastern Europe	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
Portugal	Energy Assessment (English)	04/84	4824-PO
Romania	Natural Gas Development Strategy (English)	12/96	192/96
Turkey	Energy Assessment (English)	03/83	3877-TU
	MIDDLE EAST AND NORTH AFRICA (MNA)		
Arab Republic of Egypt	Energy Assessment (English)	10/96	189/96
Morocco	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
	Energy Sector Institutional Development Study (English and French)	05/95	173/95
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector(English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
	Renewable Energy Strategy Study, Volume I (French)	11/96	190A/96
	Renewable Energy Strategy Study, Volume II (French)	11/96	190B/96

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Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91
	LATIN AMERICA AND THE CARIBBEAN (LAC)		
LAC Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--
	National Energy Plan (Spanish)	08/91	131/91
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Prefeasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
	Preparation of Capitalization of the Hydrocarbon Sector	12/96	191/96
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
	Power Sector Restructuring (English)	11/94	169/94
	Energy Efficiency Report for the Commercial and Public Sector (English)	06/96	184/96
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--
	Private Minihydropower Development Study (English)	11/92	--
	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English)	03/88	--

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Jamaica	Management Information System Phase I (English)	03/88	--
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
	Energy Efficiency Management Technical Assistance to the Comision Nacional para el Ahorro de Energia (CONAE) (English)	04/96	180/96
Panama	Power System Efficiency Study (English)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	--
	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR
	GLOBAL		
	Energy End Use Efficiency: Research and Strategy (English)	11/89	--
	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
	Women and Energy--A Resource Guide		
	The International Network: Policies and Experience (English)	04/90	--
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--
	Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93
	Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
	Development of Regional Electric Power Networks (English)	10/94	--
	Roundtable on Energy Efficiency (English)	02/95	171/95
	Assessing Pollution Abatement Policies with a Case Study of Ankara (English)	11/95	177/95
	A Synopsis of the Third Annual Roundtable on Independent Power Projects: Rhetoric and Reality (English)	08/96	187/96

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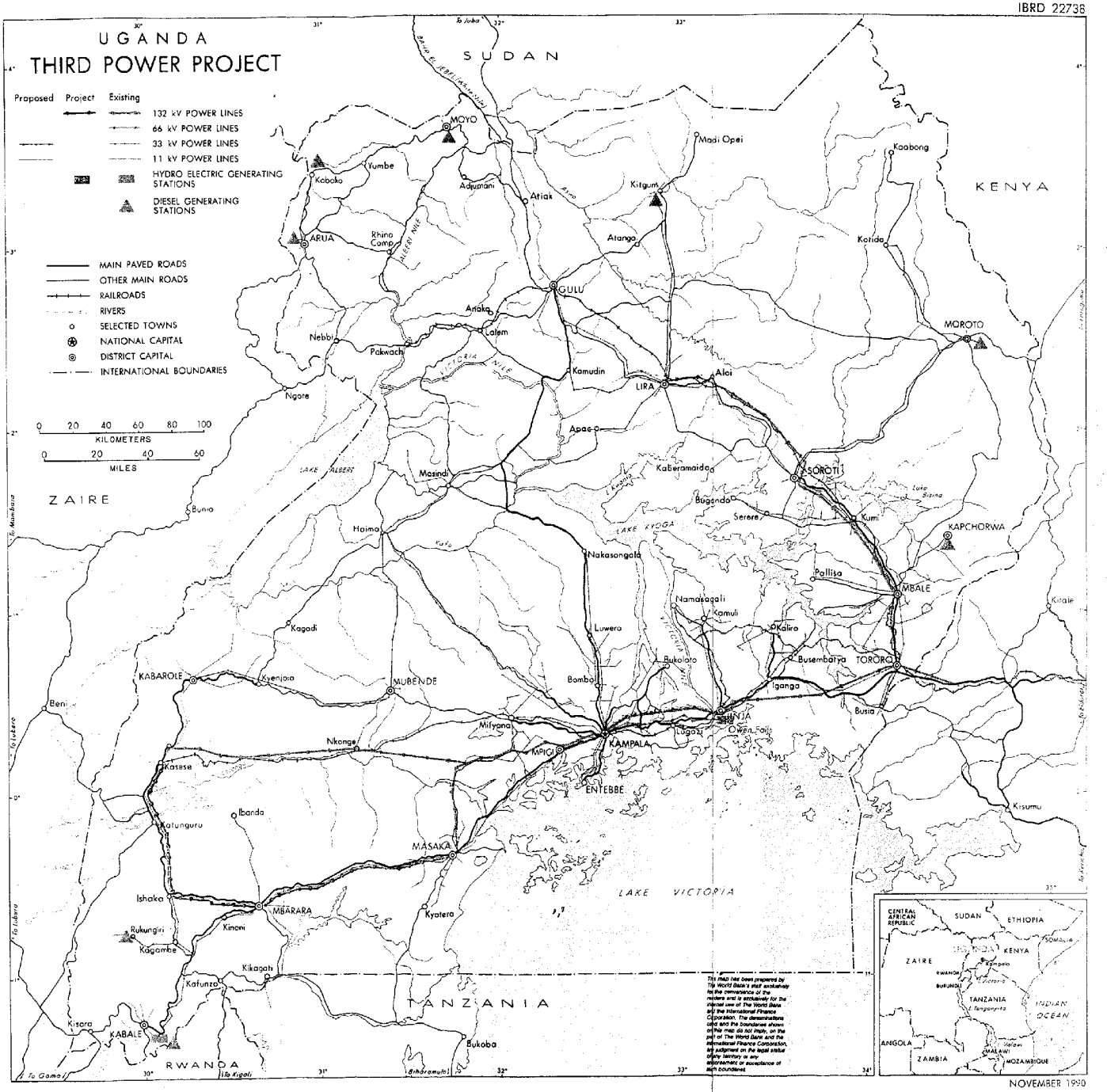

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