ESMAP

Energy Sector Management Assistance Programme

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Burundi

Issues and Options in the Energy Sector

Report No. 9215-BU

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

PURPOSE

The Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) was launched in 1983 to complement the Energy Assessment Programme, established three years earlier. ESMAP's original purpose was to implement key recommendations of the Energy Assessment reports and ensure that proposed investments in the energy sector represented the most efficient use of scarce domestic and external resources. In 1990, an international Commission addressed ESMAP's role for the 1990s and, noting the vital role of adequate and affordable energy in economic growth, concluded that the Programme should intensify its efforts to assist developing countries to manage their energy sectors more effectively. The Commission also recommended that ESMAP concentrate on making long-term efforts in a smaller number of countries. The Commission's report was endorsed at ESMAP's November 1990 Annual Meeting and prompted an extensive reorganization and reorientation of the Programme. Today, ESMAP is conducting Energy Assessments, performing preinvestment and prefeasibility work, and providing institutional and policy advice in selected developing countries. Through these efforts, ESMAP aims to assist governments, donors, and potential investors in identifying, funding, and implementing economically and environmentally sound energy strategies.

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ESMAP is governed by a Consultative Group (ESMAP CG), composed of representatives of the UNDP and World Bank, the governments and institutions providing financial support, and representatives of the recipients of ESMAP's assistance. The ESMAP CG is chaired by the World Bank's Vice President, Operations and Sector Policy, 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. The Manager of ESMAP, who reports to the World Bank's Vice President, Operations and Sector Policy, administers the Programme. The Manager is assisted by a Secretariat, headed by an Executive Secretary, which supports the ESMAP CG and the TAG and is responsible for relations with the donors and for securing funding for the Programme's activities. The Manager directs ESMAP's two Divisions: The Strategy and Programs Division advises on selection of countries for assistance, carries out Energy Assessments, prepares relevant programs of technical assistance, and supports the Secretariat on funding issues. The Operations Division is responsible for formulation of subsectoral strategies, preinvestment work, institutional studies, technical assistance, and training within the framework of ESMAP's country assistance programs.

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 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.

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FOR OFFICIAL USE

Report No. 9215-BU

BURUNDI

ISSUES AND OPTIONS IN THE ENERGY SECTOR

January 1992

This is one of a series of reports of the Joint UNDP/World Bank Energy Sector Management Assistance Programme. Finance for this work has been provided, in part, by the UNDP, and the Government of the Netherlands, and the work has been carried out by the World Bank. This report has a restricted distribution. Its contents may not be discussed without authorization from the Government, the UNDP, or the World Bank.

ABSTRACT

Burundi has a certain endowment of energy resources in the form of wood, hydropower and peat but with the present demand characteristics, population density and increase, as well as settlement pattern, the resources are either under pressure of potential depletion (wood) or are relatively costly to produce and supply (hydro resources and peat). In addition, the country's landlocked position makes petroleum products, for which it is entirely dependent on import, very costly. A dominant share of energy consumption (90%) is covered by biomass (woodfuels and crop residues) and households are the main consumer category of energy (more than 90%). Some 85% of commercial energy is imported, preempting 25-30% of the country's foreign exchange earnings. Given the above profile, the principal direction of the country's efforts in the energy sector should be towards improving the efficiency of utilization and production of energy, increasing the supply of woodfuels and lowering the supply costs of petroleum products, and strengthening institutions in the energy sector to enable them to improve planning, implementation and operations.

The main recommendations of the present report are to:

(i) improve demand management with respect to the different types of fuels, by introducing more efficient pricing policies for woodfuels and petroleum products and by fully implementing already initiated tariff reforms regarding electricity;

(ii) more systematically follow up the potential for increasing efficiency of production and consumption of energy by non-price measures, in particular with respect to charcoal and electricity, and to pursue the possibility of substituting peat for fuel oil in industry;

(iii) increase the supply of wood by further focussing on agro-forestry and improving management of existing wood resources, to improve reliability of electricity supply, and to pursue the means of lowering petroleum import costs and increasing the reliability of supply; and

(iv) further develop the capacity for overall energy planning as well as for preparing and implementing subsector plans, by extending technical assistance and other support, by clarifying areas of responsibility, and by establishing and following clear procedures and planning methodologies.

An Energy Sector Rehabilitation Project is being prepared and will complement the Energy Assessment.

ACRONYMS AND ABBREVIATIONS

AMOCO	American Oil Company
BPE	Bureau des Projets d'Education
BRB	Banque de la République Burundaise
CEBEA	Centre d'Etudes Burundais des Energies Alternatives
CEPGL	Communauté Economique des Pays des Grands Lacs
CIDA	Canadian International Development Agency
CRAES	Centre Régional Africain pour l'Energie Solaire
DF	Département des Forêts
DGC	Direction Générale du Commerce
DGE	Direction Générale de l'Energie
DGHER	Direction Générale de l'Hydraulique et des Energies Rurales
DP	Département des Projets
DRS	Département des Recherches et Statistiques
DUB	Développement Urbain de Bujumbura
EGL	Energie des Grands Lacs
FAC	Fonds d'Aide et de Coopération
FED	Fonds Européen de Développement
ICO	International Coffee Organization
INCN	Institut National pour la Conservation de la Nature
MATE	Ministère de l'Aménagement, du Tourisme et de l'Environnement
MCI	Ministère du Commerce et de l'Industrie
MCIA	Ministère du Commerce, de l'Industrie et de l'Artisanat
MDRA	Ministère du Développement Rural et de l'Artisanat
MEM	Ministère de l'Energie et des Mines
NES	National Environmental Strategy
ONATOUR	Office National de la Tourbe
PIP	Public Investment Program
PSE	Programme Spécial d'Energie
SCEP	Service Chargé des Entreprises Publiques
SEP	Société d'Entreposage du Pétrole
SINELAC	Société Internationale de l'éléctricité des Pays des Grands Lacs
SPPF	Special Project Preparation Facility
TRC	Tanzania Railway Corporation

CURRENCY EQUIVALENTS

1 Burundian Franc (FBU) = US$0.0063 (Oct. 1989)

160 FBU = US$1.00

MEASUREMENTS

GWh	Gigawatt-hour	1,000 MWh = 1,000,000 kWh
GJ	gigajoule	1000 MJ = 1,000,000 kJ
kcal	3.968 British Termal Unit (BTU)	4.19×10^{-3} MJ
kV	kilovolt	1,000 volts
MVA	megavolt ampere	1,000 kilowatt amperes
MW	megawatt	1,000 kilowatt; 1000 kW
MWh	megawatt hour	1,000 kilowatt hours = 860,000 kcal = 0.248 TOE at 34% efficiency in thermal (oil) generation
TOE	Tons of Oil Equivalent	10.2 million kcal = 42.5 GJ
MT	metric tons	1,000 kilograms
lb	pound	
stère	eucalyptus wood	450 kg
"	pine wood	300 kg
lm3	solid eucalyptus	900 kg
"	solid pine	750 kg
HV	High voltage	
MV	Medium voltage	
LV	Low voltage	

ENERGY CONVERSION FACTORS

Fuel		GJ = 10^3MJ/unit	Physical Units/TOE
Liquid fuels (tons):	Crude oil	42.7	1.00
	LPG	45.2	0.94
	Kerosene	43.1	0.99
	Jet fuel	43.5	0.98
	Gasoline	44.0	0.97
	Gasoil	42.7	1.00
	Industrial diesel oil	42.3	1.01
	Fuel oil	41.0	1.04
Electricity (MWh)		3.6 (per def.)	4.0
Fuelwood (ton)		16 a/	2.91
Charcoal (ton)		30 a/	1.46

a/ Air-dried wood, 15% moisture content wet basis (m.c.w.b.).

FISCAL YEAR

January 1 - December 31

This report is based on the findings of an energy assessment mission which visited Burundi in October 1989. The mission comprised T. Holtedahl (Mission Leader), P. Millan (Power Planner/Economist), R. van der Plas (Energy Planner), J.H. Neuteboom (Consultant, Forestry Specialist), C. Oudin (Consultant, Power Engineer), P.V. Pinheiro (Consultant, Petroleum Specialist), V. Hveding (Consultant, Energy Planner/Economist)

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SUMMARY AND PRINCIPAL CONCLUSIONS

Introduction

1. The objectives of this assessment are to evaluate Burundi's energy position, especially its energy resources and development options, and to suggest priorities among the actions that might be taken in the sector by the Government and external donors. The present report follows an energy assessment completed in 1982 (Report No. 3778-BU), and an activity completion report in 1984 (No. 012/84). Although the structure of the energy sector is basically the same as when the first assessment was carried out, the present evaluation is a self-contained review of the basic issues and options as seen nearly a decade later. Few of the recommendations in the first energy assessment have been carried out. As explained later in the report, however, the World Bank is in the process of preparing an energy sector rehabilitation project under which most of the recommendations of the present assessment will be implemented.

2. Burundi is a small, low income, densely-populated landlocked country, and its principal energy issues are related to these characteristics. Most Burundians use wood and agricultural by-products for cooking and other basic energy needs. The high population density is beginning to make fuelwood increasingly scarce and puts reforestation efforts in competition for land with agricultural production. The country is dependent on overland transport routes crossing other countries for almost all of its imports, including oil. As a result, the country faces two main difficulties with respect to petroleum products: high costs and insecurity of supply. The hydropower resource base of the country is good, transmission distances are reasonable, but unit costs for transmission as well as for distribution come out high, due to the settlement pattern, low income and low level of consumption. Peat is quite abundant but, for this resource also, high unit production costs are, inter alia, related to modest production scale.

3. The scarcity of technical and management skills affects the prospects for developing the country's energy resources, and it also reduces the scope for effective policy-making and the planning and operations of energy producing, marketing, and consuming institutions.

Energy Consumption

4. The energy situation of Burundi is characterised by a high reliance on biomass which completely dwarfs the use of modern, commercial fuels. Firewood and charcoal combined meet more than 80% of the country's energy needs, and agricultural by-products an estimated 11%. Petroleum products account for 6% and hydropower, which dominates the public energy sector investment program, covers only 1% of the total energy requirements. Final energy consumption, totalling close to 1 million tons of oil equivalent (TOE) or approximately 190 kgoe per capita is low, as is the consumption of modern fuels, at 11 kgoe per capita. The latter is explained by the low level of income, by relatively

expensive petroleum products and high connection costs for electricity, by the dominance of subsistence agriculture in the economy, and the small size of the industrial sector.

5. The consumption of commercial energy grew at an average annual rate of about 6% over the period 1980-88, i.e. at around 5% for petroleum products and close to 12% for electricity. Approximately 85% of commercial energy (predominantly petroleum products) is imported and have accounted for 20-30% of merchandise exports in recent years. Per capita consumption of electricity was around 20 kWh in 1988, one of the lowest levels in Sub-Saharan Africa.

Table 1: FINAL ENERGY CONSUMPTION, 1988

	1,000 TOE	%
Fuelwood	742	79
Charcoal	30	3
Agricultural residues	106	11
Peat	3	a/
Petroleum products	50	6
Electricity	9	1
Total	940	100

Source: Energy balance (Chapter 1).

a/ Less than 0.5%

Energy Resources

6. Burundi has a certain endowment of energy resources in the form of wood, hydropower, and peat but with the present demand characteristics, population density and increase, as well as settlement pattern, the resources are either under pressure of potential depletion (wood) or are relatively costly to produce and supply (hydro resources and peat).

7. Woodfuels and crop residues. The tree cover totals some 200,000 ha or 7% of the country's total land area. This includes natural forests, woodland savannah and tree plantations. In addition comes scattered farm trees. An estimated 90-95% of wood production is for domestic energy consumption in the form of fuelwood and charcoal. Data related to forestry and woodfuels are very poor but the country is, on the basis of best estimates, in a potentially serious situation of depletion on a national level. So far, demand appears to have been met both in rural and urban areas without price increases in real terms in later years. For certain areas, however, there are already quite significant imbalances between wood consumption and sustainable supply, and potential problems affecting the welfare of the rural population as well as the environment will be emerging unless determined action is taken. High population density, clearing of land for agricultural purposes, and dependence on woodfuels are contributing factors. Industrial plantations coming to a stage of maturity are seen to yield substantially in excess of commercial offtake, which would indicate a mismatch in the allocation of production as between industrial plantations and other forest resources and, possibly also, in the allocation of public resources aimed at increasing wood supply.

8. Hydropower. The country is rich in hydropower resources. The theoretical potential has been estimated at 6,000 GWh/year. In practice around 1,500 GWh/year from about 40 projects are seen to be economically exploitable. These are located in two distinct regions of the country, the north-western part of the country and the southern region. In addition, there are other hydroelectric potentials that must be developed in cooperation with other countries, as they are found along rivers forming boundaries. Compared with current generation of 115 GWh/year (domestic and import, 1988), the economically exploitable potential would allow a 13-fold increase in supply, indicating that the limitations are related not to the resource base but rather to the economic basis (availability of capital for generation facilities and for transmission and distribution network) and planning capacity for expanding the system. Present domestic hydropower facilities consists of 27 power plants with a total installed capacity of 32 MW, two of which alone represent 81% of the total installed capacity in the country. Thermal plants provide only 2% of the power generated in the grid system. Burundi has imported power for a number of years from Zaire's Ruzizi I plant but in a decreasing proportion to total energy supplied to the network (1988: 10%). In addition, Burundi takes power from Ruzizi II, commissioned in 1989 and jointly owned by Burundi, Zaire and Rwanda. The contractual arrangement with Zaire which allows Burundi to import considerably more electricity than it does at present (and at no cost, up to a time limit) plus the possible addition of a third unit at Ruzizi II imply that Burundi will not need to expand its own capacity until around 1998. In the meantime the existing power master plan needs to be revised as a basis for further subsector development.

9. Peat. Proven reserves are large, some 55 million MT, predominantly made up of lowland bogs, at present barely in production, and of highland bogs from which some 12-14,000 MT are extracted annually. Highland bogs are easier to exploit and do not seem to pose significant environmental problems. Present use of peat is basically limited to institutions, whereas the potential for significant increases lies with households and industry. Technical problems related to inconvenience in use have to be overcome for households to be interested in peat for cooking, in addition to the question of cost. A more likely and immediate application is as a fuel in industry, although the feasibility (primarily economic/financial) needs to be confirmed. Apart from the question of cost, environmental issues will have to be addressed before any large scale extraction is undertaken, especially from the lowland bogs.

10. Hydrocarbons. Seismic investigations and an aeromagnetic survey preceded the drilling of exploratory wells in 1987 on the Ruzizi Plain, but the results were inconclusive. Further exploratory work is planned offshore in Lake Tanganyika but the combination of until recently low oil prices and high risks have slowed down activities. As indicated above, Burundi is entirely dependent on imports to cover its requirements for petroleum products.

11. New and renewable sources of energy. Despite a relatively promising environment and high conventional energy costs, new and renewable energy technologies have had limited application and alternative energy sources are not likely to provide substitutes for traditional or modern energy sources on any significant scale in the mid-term future. Most options are non-economical at present day technologies and energy prices. Biogas digesters and solar systems appear to offer, however, a limited potential mainly in isolated areas. The environmental benefits of the former may be just as important as their energy contribution.

12. The Government's declared objectives for the energy sector emphasize (a) the rational development and exploitation of national energy resources, (b) the supply of suitable forms of energy for rural development, (c) the supply of inexpensive energy for industrial and artisanal activities, (d) the efficient utilization and maintenance of existing energy infrastructure, and (e) a reduction in the dependance on foreign energy supply. Pursued within reasonable limits and through rational policies, these objectives should contribute to the promotion of the overall objectives of sufficient supply at least cost of forms of energy adapted to the needs of the country. The following paragraphs will examine the policies and activities carried out within the energy sector in Burundi, the options for improvements, and recommend measures and actions to be taken by the Government with the assistance of the donor community.

Energy Demand Management

13. Since raising the productive potential of the energy sector is feasible only over the longer term, measures aimed at increasing the efficiency of energy use are of particular importance at least over the short- to medium term. Appropriate energy pricing reflecting the economic cost of supply is the most important instrument for effective demand management. The Government has made progress in the last year in moving towards more realistic electricity prices. However, a more general awareness and use of pricing as a tool in the energy sector is required, together with direct, non-price measures focussing on specific energy conservation. For reasons related to quite wide differences in cost between various forms of energy, low level of income, and technical constraints, the energy subsectors in Burundi are more clearly defined, less interwoven, and more closely associated with specific classes of users than is usually the case. The scope for substitution between fuels therefore appears at present to be relatively limited.

Energy Pricing

14. Present prices of fuelwood and charcoal do not properly reflect economic costs. Prices of both fuels are basically market-determined. The Government intervenes by setting a stumpage fee of BUF 415/stere for wood originating in public forests and plantations, but the official price is rarely enforced. The market price for wood around Bujumbura, BUF 1,000/stere, is also below the long-run marginal cost of wood (BUF 845/stere (US$5.30) 1/ at site) which, including transportation and distribution margins, is calculated at BUF 1,650 (US$ 10.30). A bag of charcoal (45 kg) in Bujumbura costs around BUF 750 (US$ 4.70), whereas the economic cost based on the LRMC of wood is close to 1,200 (US$ 7.50). These price differences reflect, inter alia, the perception of non-commercial wood as "free", the low purchasing power of consumers relying on fuelwood for cooking, limited markets for commercial fuelwood as well as for higher value uses of wood, and supply from sources where the total cost of wood is not fully perceived by the supplier. Lower market price leads to higher consumption of wood than is desirable from society's point of view, it does not give proper incentives to develop and adopt efficient methods of charcoal production nor to use improved stoves and, finally, it means that the rural wood producing population is subsidizing urban households. It is therefore recommended that the

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1/ US$ 1 = BUF 160 (Oct. 1989).

pricing and taxation of commercialized wood and charcoal be reviewed and measures to more effectively enforce collection of fees and taxes be implemented. The timing is relevant with a number of industrial plantations coming to maturity and with the completion of the Second Forestry Project financed in part by the World Bank. Prior to the price and tax revision, an awareness campaign as to the value of wood should be initiated.

15. Electricity tariffs have been periodically adjusted over the last years but the changes were, until recently, not based on any complete and sound analysis of the long-run marginal cost of generation and supply. A study was carried out in December 1989 and, based on it, the Government decided to implement in April 1990 a comprehensive electricity tariff reform. Medium-voltage rates were immediately adjusted to the estimated LRMC values (USc 12/kWh declining to USc 4/kWh with the hours of utilization, plus a fixed charge for subscribed capacity), while for low-voltage users the adjustment is phased with an initial increase of 27% for all consumption above 375 kWh per month (present tariff USc 10-12/kWh vs a LRMC of USc 14/kWh). A social tariff for consumers using less than 75 kWh per month has also been established. The tariff reform also eliminated the system of free electricity to high government officials and to the personnel of the power and water utility. Prior to this reform, the high connection fee was reduced to cover only the individual cost of connection and a term payment plan was introduced. However, the use of expensive high-standard material and equipment from countries involved in the extension of lines instead of from low-cost developing countries still makes connection expensive for large segments of the population. It is recommended that the initial restructuring of the tariffs be followed up by further adjustments towards the LRMC for low-voltage and other users, that annual adjustments be made to compensate for inflation, and that a differentiation between peak and off-peak tariff be introduced for large industrial users.

16. The prices of petroleum products are controlled by the Government and have been unchanged since 1983, with the exception of fuel oil which has been moderately increased. 2/ The Government has strongly resisted any attempts to liberalize the prices of petroleum products and has adjusted its duties and taxes to compensate for variations in product prices and the exchange rate. To quite some extent, the fall in international oil prices has been offset by the fall in the Burundian franc vis a vis the US dollar. Purchases of modest quantities of petroleum products and high overland transportation costs (more than 50% of initial cost FOB ocean port) explain the high price CIF Bujumbura. Retail prices, however, are lower than in most of Europe and in neighboring landlocked countries. Thus, relatively moderate government revenues compensate for high product and transport costs. In addition, an overvalued Burundian franc reduces the real value of prices and of government duties and taxes. The official price structure is complex and main user-related elements in the structure are low compared to the cost they are supposed to cover. A review of the level and structure of petroleum product prices is therefore required and recommended. The increase in oil prices in September 1990 underscores the urgency of a Government initiative to introduce a regime of adjustable petroleum prices, following movements in the international market. Furthermore, regulations by the Burundian Government related to the overland transportation of petroleum products have led to transport costs which

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2/ *In September 1990, petroleum product prices in Burundi were increased by about 30%, partly reflecting the new situation in the international market.*

are higher than otherwise dictated by market conditions. The Government has agreed to deregulate international truck transportation and it is recommended that this liberalization be implemented to stimulate competition and that the price structure of petroleum products be reviewed regularly to encourage importers to make use of the least cost supply route.

Non-price Measures for Improving Efficiency

17. Woodfuels. Consumption of woodfuels in traditional stoves is quite inefficient and considerable scope for improvements exists, primarily with respect to charcoal stoves. This is less the case with respect to firewood which is mainly used by the rural population and burned in 3-stone open fires which in themselves are "free" and use a resource which is also perceived as free. Such users of fuelwood have less incentive to change their habits, and projects targeting these users have not been successful. Charcoal stoves, on the other hand, have a monetary cost, as does the charcoal. Improved stoves have been promoted by various public institutions but although the charcoal savings (more than 30%) imply a very short payback period, the number of stoves sold has gone down in the last couple of years. Cost and quality of the stoves are partly reasons for the lack of success, but the problem is mainly institutional. Backing from the Government and an effective institution to organize production and marketing of the stoves is needed. It is recommended that the improved charcoal stove program be revitalized, that the management be entrusted to an organization suited for the purpose (in the process of being identified), with the intent of making the sale of stoves a commercially viable activity run by the private sector. A project to this effect is proposed.

18. Inefficient charcoal production based on traditional techniques is responsible for large quantities of wood wasted. Improved carbonization methods have been introduced together with training, and savings of 50% have been demonstrated. If fully implemented, a program to increase efficiency in this area could have a quite significant impact on the woodfuel balance. There are few incentives to change, however, with low wood prices and little follow-up. It is recommended that the present activity is reoriented (by, inter alia, establishing closer links between wood owners and charcoal producers and by organizing and training of the latter) and managed as a project with the Département des Forêts and the Direction Générale de l'Hydraulique et de l'Energie Rurale as counterpart organizations, and that the pricing and taxation review take into consideration the need for proper incentives to adopt improved techniques.

19. Electricity. Total losses in the electricity system were of an order of 18-20% in 1989, up from previous years. They are high both at the transmission level, given the small network, and at the distribution level. The latter is partly explained by the old age of the lines in the capital and in another major town, and they are in urgent need of rehabilitation. There are also indications that non-technical losses are a quite significant part of total losses. A program of revision of electrical meters is in progress and the findings so far confirm the need to continue this work. It is recommended that the rehabilitation of the Bujumbura and Gitega distribution systems be undertaken, and that other measures to reduce technical losses be identified and implemented.

20. Petroleum products. Although the industrial base and the consumption of petroleum products by industry in Burundi is limited, savings on the import bill of some significance could be made by following up a study in 1986 of the 15 largest industrial enterprises. Measures identified are of a conventional kind and require little or no investments, but lack of know-how and incentives have prevented implementation. It is recommended that advisory assistance be given to help industry acquire and install metering and regulating devices. Higher investment costs but also larger savings in terms of fuel oil are associated with the use of indigenous peat or surplus electricity by boiler conversion or by installing electric boilers in some of the major industrial establishments. Initiatives have been taken towards a conversion of boilers to electricity. The envisaged concept is, however, not economically justified. Nor is an arrangement based on interruptible power advisable in the present context due to perceived problems of effectively managing such a system. It is on the other hand recommended that the possibility of substituting indigenous peat be pursued by establishing the technical, financial and economic viability of such an option and, if confirmed, by choosing a step-wise approach of implementation. A project is proposed, focussing on smaller industries to begin with.

Options to Increase Energy Supplies

21. Overall, availability of energy appears until now not to have been a major constraint on economic development, except for the low penetration of electricity which may be a handicap of some significance to productive development outside urban centers and an obstacle to the extension of social services. But, although the situation so far has been reasonably satisfactory, the rapid growth in population and continued economic development give rise to important challenges with respect to supply within all the major energy subsectors.

22. Wood. Uncertainty with respect to the resource base and its development combined with indications of depletion of the natural tree cover, due to the need for fuelwood and to the clearing of land for agricultural purposes, create a situation where measures should be taken, in parallel, to improve the level of information and to restore and increase the tree cover. Effective measures are all the more important considering both the welfare implications that a fuelwood shortage will have on the rural population in particular, with their limited substitution possibilities, and the negative environmental impacts of deforestation. In view of a potential surplus for a number of years ahead of commercialized wood from maturing industrial plantations, it is important that the primary focus is on agro-forestry, with the farming population as target group. It is recommended that a national inventory of wood resources and yields be carried out, that the organization of the woodfuel sector (both for charcoal and commercial firewood) be studied, and that a national household energy survey be done, to form a basis for planning and monitoring with respect to supply and demand of household fuels. Furthermore, it is recommended that increased emphasis should be placed on agro-forestry projects, nursery programs and extension services. The design of the programs should take into account the need to elicit the participation of the rural population. Finally, it is recommended that a strategy should be designed for the management of wood resources in general, and for the exploitation, maintenance and marketing of wood from maturing industrial plantations in particular. The role of the private sector with respect to managing public plantations should be considered. These recommendations should be carried out partly under ongoing projects and partly as new activities.

23. Electricity. Operating problems in the grid are fairly common and the number of incidents interrupting the supply of electricity is quite high. Mostly this can be ascribed to the quality of maintenance work which is in general low, due to lack of training, inadequate stocks of spare parts and material and to deficiencies in logistical support. The planning of maintenance is too general and, with the exception of Rwegura, no detailed program exists for preventive maintenance. Isolated centers relying exclusively on supply from thermal power plants also experience quite frequent failures. It is recommended that detailed preventive maintenance programs be prepared for all power plants, substations and transmission lines, that maintenance personnel be given additional training, that a detailed survey be undertaken of the state of diesel units in isolated centers, and that diesel power plants kept in reserve to supply the grid be maintained and kept in operating condition at all times.

24. Based on its own existing hydropower capacity, its share of an expanded Ruzizi II and imports from Ruzizi I, Burundi's needs for power are covered up to around 1998. For new capacity at that time, there are both regional and domestic options. For various reasons, the regional Rusumo Falls project has, until recently, not been actively pursued, whereas a study is being prepared for a Ruzizi III project. Meanwhile, Burundi needs to determine the priority of its domestic options. A power master plan was completed in 1988, but a too limited number of alternative strategies were considered. For the potential sites in the two most water resource-rich regions in the country there is only one for which a feasibility study has been made, despite the fact that preliminary findings show other alternatives to be more promising. Given the time requirements for implementing expansion plans, it is recommended that a limited number of additional feasibility studies for specific sites be prepared as soon possible, as a basis for carrying out a more comprehensive master plan resulting in a least cost development plan. In the meantime, expansion of the grid-connected generating capacity should be deferred to avoid sub-optimal solutions. Expansion of connections in areas where electricity is available should, on the other hand, be given high priority.

25. Of the country's 115 municipalities, 32 have their main village electrified while 83 completely lack electricity service. A dialogue between the local authorities and the Government regarding extensions and possible sources of electricity was recently completed, but no real plan for rural electrification exists nor have proper economic evaluations of identified projects been carried out. Development in this area is, furthermore, hampered by institutional ambiguities and inefficient management of existing rural services. It is recommended that a comprehensive rural electrification master plan be prepared, preceded by institutional reform as part of the study. Meanwhile, only projects that pass the economic threshold for rural electrification projects (as discussed in the main text) should be implemented.

26. Peat. The development of peat as a fuel on any scale is linked to its acceptance by households and in industry. As indicated earlier, inconvenience in use and cost are the main obstacles to penetration of the household market. Present work to overcome these obstacles should be continued on a limited scale. The successful use of peat in industry in other countries and preliminary calculations based on data for Burundi, indicate that this avenue is worth pursuing. The conversion of industrial boilers to peat should be studied, as recommended above, and peat should continue to be promoted in

the institutional sector which is the main user at present. Environmental impacts (possible drainage problems and competition with agricultural uses for land) of extraction need to be considered and monitored.

27. Petroleum products. The import of these products give rise to three supply-related issues: (a) source of supply and product costs, (b) supply routes and transport, and (c) storage and security stocks. The small size of the Burundian market for petroleum products and the fact that it is serviced by five operators effectively bars it from approaching the international market for its requirements. At present, the local operators cover their needs by purchasing modest quantities individually from multinational companies that own and operate depots in Mombasa/Nairobi and Dar es Salaam. With a weak bargaining position, the importers end up by paying a price above the parity price. Based on the options open at present, it is recommended that the Government, in cooperation with the local operators, prepare a strategy for reducing product prices by assessing the costs and benefits of pooling purchases and entering into negotiations with possible suppliers in Kenya and Tanzania. The question of least cost source should be considered in relation also to supply security and to transport routes (see below). Other possible supply arrangements should be considered as they become an option, including regional solutions which are at present under study by the World Bank.

28. The dominant supply route for imports is from Nairobi via Uganda and Rwanda (the northern corridor) but transportation by truck or, in particular, railway/barge from Dar es Salaam (the central corridor) is considerably less expensive. Capacity problems and poor infrastructure severely limit the use of the central corridor, however. Under a regional projects involving, inter alia, the World Bank, the Tanzanian railway will be strengthened and dedicated block trains providing the landlocked countries with reliable goods transport services will be supplied and are expected to improve the situation significantly within 2-3 years. Road improvements along the central corridor are also gradually making this route more accessible. Competition among transport operators should increase as the Government, as part of negotiations with the World Bank on the country's transport sector policy, has agreed to eliminate regulations protecting national transporters. It is recommended that the Government monitor the situation with regards to the different transport options and see to it that the regulatory framework (e.g. the official price structure) is adjusted so as to stimulate the use of the least cost alternative.

29. For a landlocked country, minimum security stocks of petroleum products of a size consistent with what the country can afford to hold should be enforced. At present, this is not the case but the Government plans an increase of minimum stocks corresponding to 90 days' consumption. This is considered too high, risks and costs taken into consideration. It is recommended instead that a policy of 30 days' security stocks (which are additional to approximately 30 days' operational stocks) be implemented and a plan for their financing, cost coverage, use and replenishment, be prepared in cooperation with the petroleum operators. Existing reserve depots should be put in service from the point in time needed, probably as an integral part of the main depot in Bujumbura.

Energy and Environment

30. Environmental impacts of and risks associated with energy supply and use are primarily related to traditional sources of energy, i.e. fuelwood, charcoal and (potentially) peat. Rapid population growth will, if unchecked, create major ecological imbalances which, in part at least, can be attributed to energy. Although potential environmental consequences of recent, large hydropower projects have been taken into consideration during planning and implementation, a systematic and overall approach to assess and alleviate environmental impacts related to energy supply in general does not exist. The matter is not energy-specific but a general one, however and it is recommended, therefore, that a national environment strategy be designed in order to provide guidelines for environmental protection and management. These guidelines (which should, inter alia, include institutional setup and environmental tools) should be adopted in all matters related to energy development to ensure that environmental impacts are systematically taken into consideration as part of project preparations. The Direction Générale de l'Energie should have responsibility for the application of the guidelines and liaise with institutions that have specific environmental responsibilities.

Institution Building

31. Energy planning and policy formulation. The quite different structures of the respective energy subsectors (electricity, biomass, petroleum, peat, alternative energy sources) and their consequential different needs in planning and management are broadly reflected in the institutional framework for energy planning and management in Burundi. Planning, implementation and follow-up is generally carried out within each of the main subsectors, while the Direction Générale de l'Energie (DGE) of the Ministère de l'Energie et des Mines (MEM) has in principle overall responsibility for the energy sector.

32. The foremost task of the DGE is that of keeping an overview of the energy sector as a whole, assessing requirements and priorities as between subsectors, giving general guidelines for subsector development, and ensuring coordination. It is essential that the DGE supports and strengthens the respective subsector institutions rather than duplicating or taking over their work. Weaknesses should be corrected by strengthening the institution involved and, if warranted, giving it more resources. It is therefore recommended that the DGE focus on overall energy planning, overseeing and giving guidelines for the subsector agencies, and that for this purpose a Department of Planning, now under consideration, be established. Physical planning and implementation for individual subsectors, on the other hand, should be the responsibility of the subsector agency, supervised by the DGE. A case in point is the REGIDESO, the national power and water utility, which should be given full responsibility for planning the expansion of the electricity supply system, which today is done by the DGE as one of their main activities.

33. Coordination in a decentralized system would normally be achieved by establishing uniform investment criteria, but with the great dissimilarity between the energy subsectors (electricity dominated by clearly identifiable projects, the biomass subsector more by ongoing programs and externally financed technical assistance), the use of formal, objective criteria may not always be possible. Setting of priorities may call for judgement by the DGE. Important cases should be referred to the newly

created National Commission for Water and Energy. It is recommended that clear procedures and criteria be established and applied for evaluating projects and programs in the individual energy subsectors, and that a process involving the DGE (ensuring the application of procedures and criteria by subsector agencies) and the National Commission be instituted. Furthermore, it is recommended that the acceptance of externally financed projects in the energy sector be subject to assessment and recommendations by the DGE. This is important, in order to avoid a donor driven energy agenda prevailing over investments and activities that would be more consistent with national objectives and criteria if developed on the basis of clear procedures and criteria. The role and functions as indicated of the DGE will require a strengthening of staff, in particular the agency will need to recruit economists and key personnel with a background in energy planning issues and management.

34 Important issues that have direct bearing on the energy situation of the country are not properly addressed at present. In the petroleum subsector, the central government agency is the Ministère du Commerce et de l'Industrie. This would seem a logical arrangement if regulating commercial activity were the overriding concern. With the host and type of issues related to petroleum products, as indicated above (supply, cost, price structure, efficiency, security stock and storage), it is recommended that the DGE have the responsibility for energy-related aspects of petroleum products in close cooperation with the present ministry looking after commercial aspects, and liaising with the petroleum operators on supply, price and storage questions. There are at present also serious gaps in the management of woodfuels, i.e. no one institution has an in-depth understanding of both fuelwood supply and demand question. This applies also to household energy issues more generally. Donor activities are also in need of better coordination. The Département des Forêts (DF) should naturally retain its role with respect to the woodfuels supply issues, but it is recommended that the DGE with its focal energy orientation take responsibility for monitoring household energy matters, in cooperation with the DF. It would not be necessary to create a new unit in the DGE for this purpose as one of its departments already has responsibility for alternative household energies. Additional staff with relevant background would be needed, however, and this applies also - and in particular - to the additional responsibilities for the DGE for petroleum matters. Technical assistance would be required for this specialized field.

35. Operating entities. In the power subsector, REGIDESO is in the process of reforming its organization and procedures in order to recover from serious operational and financial difficulties. The reform plan is carried out under an agreement with the Bank within the framework of a structural adjustment loan. While REGIDESO has committed itself to operating as a commercial enterprise and carry out the required measures for a successful reform, the Government has indicated that it will establish a tariff policy for electricity and water based on the long-run marginal costs, increase the capital of the enterprise and pay operating subsidies for all investments that are economically viable but not financially attractive from the point of view of REGIDESO. The reform plan has, however, had a slow start and most measures remain to be implemented. Assisted by the World Bank, steps are being taken to speed up the process. In line with recommendations above, an adequate capability for planning of generation, transmission and distribution should be urgently established within REGIDESO. Also, the delimitation of responsibilities for rural electrification between REGIDESO and the agency involved within the Ministère du Développement Rural et de l'Artisanat should be clarified.

36. With respect to foresty and household energy, adjustments and strengthening are required to enable the institutions to meet the challenges ahead. It is recommended that the Département des Forêts, as far as energy-related matters are concerned, adapt its organization and strengthen its capacity to address issues such as determining and monitoring the forest resource base, preparing policies on exploitation and maintenance of wood resources, preparing and implementing agro-forestry projects, monitoring the improved carbonization program, and reviewing and enforcing woodfuel pricing and taxation. It would seem logical that this process of adaptation and strengthening of the DF be carried out as part of the finalization of the Second Forestry Project. Increased attention to and improved coordination of household energy matters will require an expanded scope for the DGE, as indicated above, although actual implementation of projects and programs should remain the responsibility of different organizations, as is the case today. This includes activities related to coordination and monitoring of new and renewable energy technologies. The ongoing Programme Spécial Energie through the GTZ should provide the required support. Finally, it should be mentioned that responsibility for development, production and marketing of peat lies with the parastatal company, ONATOUR, within the MEM. Its organization was restructured a few years ago and has the capacity for dealing with increases in production and sales.

Investment Requirements and Technical Assistance

37. Investment planning is at this juncture subject to considerable uncertainty. The electricity subsector completely dominates investements in the energy sector, in fact in the Government's investment program for the Fifth Five Year Development Plan, 1988-92, projects in that subsector account for 97% of the US$45 million (1986 price level) program of energy investments. As indicated above, no addition to the generating capacity of the interconnected system should be needed before around 1998 and in the absence of a satisfactory master plan, expansion of generating capacity should be deferred. Expansion of connections in areas where electricity is available should, however, be pursued. A rural electrification master plan is also needed before any significant commitments should be made in this area. Given the excessive investments of the past and the critical financial situation of REGIDESO, the Government has agreed not to undertake new investments in the power sector without a new and thorough review of the economic and financial viability. Therefore, the bulk of the investment requirements in the energy sector cannot be estimated at present, and an investment program is not available. Direct investment requirements in subsectors other than electricity are modest and would mainly include rehabilitation of the Gitega petroleum depot around 1995 (US$ 100,000) and possible industrial boilers using peat if this alternative is proven to be attractive.

38. Technical assistance. The growing complexity of strategy and policy decisions calls for increased technical assistance corresponding closely to the main sector objectives. In addition, strengthening of the energy subsector agencies and institutions are required to enable them to address the major challenges within their respective areas. Particular consideration should be given to training and manpower development, policy and institutional evaluations and preinvestment studies. It is recommended that the Government and potential donors pay special attention to the following requirements:

(a) for the Direction Générale de l'Energie, (i) the externally financed Programme Spécial d'Energie (PSE) should be continued to assist in establishing a structured approach to energy issues; (ii) assistance is needed to establish a planning unit within DGE, to prepare and implement procedures and criteria for energy planning and follow-up, to be applied by the DGE as well as by energy subsector agencies, and to develop the analytical skills of local staff through training in energy planning, project analysis, and pricing issues;

(b) for the woodfuels and household energy subsector, (i) assistance will be required to carry out a national inventory of wood resources and yields, a study on the organization of the woodfuel sector including economic cost and pricing of wood and charcoal, and a household energy survey; (ii) the Département des Forêts needs to be reinforced in order to design a strategy for the management of wood resources on a national level, to implement a policy that focuses on agro-forestry, and to revitalize the much-needed improved carbonization program; and (iii) assistance should be provided to the DGE to assume the role and functions of planning and monitoring of household energy matters;

(c) for the electricity subsector, (i) a limited number of feasibility studies have to be undertaken as soon as possible to be used as a basis for the preparation of a power master plan; in addition a rural electrification master plan is needed quite urgently; (ii) the implementation of the reform plan for REGIDESO should be accelerated and its capability for physical planning should be established; (iii) a detailed preventive maintenance program should be elaborated, and loss reduction measures be identified and implemented;

(d) for the petroleum subsector, (i) assistance would be needed by the DGE to enable it to assume the role and functions associated with overall management and monitoring of energy-related petroleum issues, inter alia, through training of local staff abroad and at home; (ii) expertise with an appropriate international background is required to assist in planning and implementing a strategy for reducing petroleum product cost and for reviewing petroleum product prices and price structures; and

(e) for energy efficiency and substitution options in industry, assistance is needed to evaluate peat as a substitute for fuel oil, and to advise on the implementation of existing proposals to reduce specific energy consumption.

Energy Sector Rehabilitation Project

39. Most of the recommendations presented above will be implemented during the execution of an Energy Sector Rehabilitation Project financed by the World Bank. The appraisal mission for this project was done in June/July 1990 and approval is expected in the first quarter of 1991. The broad objectives of the project are to promote rational energy policies and to strengthen the efficient management of energy resources. The project aims to develop efficient institutions in the sector, and

improve the quality of public investment, increase the efficiency in the use of energy resources through reforms in the pricing structure of electricity, petroleum products and woodfuels, expand the access of the population to electricity and reduce negative environmental effect of the use of energy.

40. The main components of the project are the following:

(a) Energy sector institution building

(i) implementation of the Rehabilitation Program for REGIDESO that includes a management assistance partnership program with a foreign operator, a restructuring of the financial base of the entreprise, the construction of limited new facilities to improve operations and training for its personnel;

(ii) pre-feasibility and feasibility studies for selected hydroelectric power projects and up-date of the power sector Master Plan;

(iii) institutional strengthening of the Direction Générale de l'Energie so that it can assume its leadership role in the areas of planning, coordination and control of the energy sector;

(iv) institutional strengthening of the Direction de l'Hydraulique et des Energies Rurales in the Ministère du Développement Rural et de l'Artisanat so that increased access to electricity in rural areas can be achieved efficiently;

(v) implementation of pricing policies reflecting the economic cost of supply of electricity, petroleum and woodfuels; and

(vi) coordination and monitoring of the public investment program in the energy sector.

(b) Biomass and household energy

(i) execution of a Charcoal Efficiency Program to disseminate improved techniques for the production of charcoal and sensitize charcoalers to the issue of deforestation;

(ii) continuation of the Improved Charcoal Stoves Program which aims at reducing charcoal and wood consumption;

(iii) a household energy consumption survey to improve knowledge with respect to energy demand and to strengthen the planning process; and

(iv) a feasibility study of peat substitution in secondary industries to determine the viability of increasing the use of these resources.

(c) Rural electrification

(i) execution of a Rural Electrification Master Plan to evaluate potential projects in rural areas and propose solutions to institutional issues in the subsector; and

(ii) execution of some economically justified extensions of the distribution network in rural areas.

(d) Power subsector

(i) doubling of the 110 kV transmission line from Bubanza to Bujumbura and extensions in associated substation; and

(ii) implementation of an intensive program of new connections and extension of the distribution network in urban areas.

Table 2: SUMMARY OF RECOMMENDATIONS AND PRIORITY ACTIONS

Issue	Recommendation	Responsibility	Proposed Action/ Assistance	Status
Energy Demand Management				
Prices of woodfuels not reflecting economic cost	Review pricing and taxation of commercial wood-fuels and collection policy	Département des Forêts	Technical assistance required for study and implementation	Inclusion in a possible next phase of ongoing Second Forestry Project proposed
Electricity tariffs below LRMC for low-voltage and other users	Follow up initial re-structuring of tariff	REGIDESO	Study already carried out	Government agreed to further adjustments under proposed ESRP (Energy Sector Rehabilitation Project)
Rigid petroleum price structure, fixed price policy	Review level and structure of prices and initiate flexible pricing policy	Ministère du Commerce et de l'Industrie	Study already carried out	Government agreed to carry out recommendation prior to ESRP effectiveness
Low extent of dissemination of improved charcoal stoves	Revitalize stove program, strengthen institutional setting, and involve private sector	ONATOUR and DGE	Technical assistance required for training and promotion; equipment. Cost: US$ 315,000	To be carried out under proposed ESRP
Charcoal production generally based on inefficient techniques	Reorganize and revitalize charcoal efficiency program and reconsider taxes/prices	Département des Forêts and DGHER	Technical assistance needed for training and promotion; equipment. Cost: US$ 615,000	To be carried out under proposed ESRP
High electric power losses	Prepare a loss reduction plan and rehabilitate Bujumbura and Gitega distribution systems	REGIDESO	Technical assistance and equipment required	REGIDESO to present plan for loss reduction by mid-1991; KfW-Germany to finance rehabilitation
Consumption of fuel oil in industry contributes to high petroleum import bill	Pursue potentail for substituting peat and implementing fuel saving measures	Direction Générale de l'Energie and ONATOUR	Feasibility study for peat project and advisory services for industry. Cost: US$ 263,500	Feasibility study to be carried out under proposed ESRP; funding needed for advisory services

Issue	Recommendation	Responsibility	Proposed Action/ Assistance	Status
Energy Supply Options				
Lack of data on wood resource base and its development	Carry out national wood resource inventory and develop woodfuel management information system	Département des Forêts	Technical assistance required for study and training; equipment. Cost: US$ 700,000	Inclusion in next phase of Second Forestry Project proposed; additional sources may be considered
Insufficient basis for planning and monitoring of household energy sector	Carry out a national household energy survey and strengthen the Département des Recherches et Statistiques	The Direction Générale de l'Energie and the Département des Recherches et Statistiques	Technical assistance required for survey and training. Cost: US$ 170,000	To be carried out under proposed ESRP
Potential general depletion of wood resources combined with potential surplus of wood from public plantations	Continue shift of focus towards agro-forestry, and prepare a strategy for the management of wood resources	Département des Forêts (DF)	Technical assistance to support reorientation and strengthening of the DF required, as well as for planning and implementation of resource utilization	Inclusion in next phase of Second Forestry Project proposed; additional sources of funding may be considered or required
Irregular supply of electricity	Prepare detailed preventive maintenance plan and maintenance training program	REGIDESO	Program to be prepared and training implemented as part of the reha-bilitation program for REGIDESO	REGIDESO to present maintenance plan by mid-1991
Need for additional (hydro) power capacity to cover electricity requirements after 1998	Prepare a least cost development plan for the power sector based on a more complete set of feasibility studies	REGIDESO	Technical assistance required for feasibility studies and least cost development plan. Cost: US$ 3.48 mill.	To be carried out under proposed ESRP
Electrification of rural areas taking place without proper planning and evaluation	Prepare a rural elec-trification master plan and deal with institutional issues	DGHER and REGIDESO	Technical assistance required for preparation of master plan. Cost: US$ 300,000	To be carried out under proposed ESRP
Small quantities of petroleum purchases by 5 distributors puts Burundi at a price disadvantage	Prepare a strategy for reducing prices paid internationally by assessing the costs and benefits of pooling purchases	Ministère du Commerce et de l'Industrie in cooperation with the Direction Générale de l'Energie (DGE)	Technical assistance required for preparation of strategy and for negotiations. Cost: part of costs for support to DGE (see below)	Support to DGE in petroleum matters to be provided under proposed ESRP; additional funding for negotiation expertise will be required
Costly international transportation of petroleum products into Burundi	Eliminate protection of national transport operators and adjust regulatory framework to encourage least cost transport alternatives	Ministère des Transports, Postes et Télécommunications and the DGE	Deregulate international tran-sportation and implement revised petroleum price structure	Government agreed to carry out recommendations under Transport Sector Project and ESRP
Lack of policy regarding minimum (affordable) security stocks for petroleum products	Plan and implement a policy of 30+30 days' stocks, including financing and cost recovery	Ministère du Commerce et de l'Industrie together with the DGE	Prepare and implement the plan in cooperation with the petroleum importers	Government in the process of reconsidering their policy in the light of recent international events

Issue	Recommendation	Responsibility	Proposed Action/ Assistance	Status
Institution Building				
Need for clarification of responsibilities for planning and implementation within the energy sector, for institutionalizing overall planning functions and for monitoring household and petroleum energy areas	DGE to focus on overall energy planning, and subsector institutions on physical planning and implementation; certain new units in DGE to be created with associated manpower support	The DGE, REGIDESO, DGHER, the Département des Forêts	Technical assistance required for preparing and implementing changes; key professionals to be hired and trained. Cost: US$ 500,000 for DGE strengthening (will also cover next activity)	To be carried out partly under ESRP, partly proposed funded under the possible next phase of on-going Second Forestry Project, partly as component of Programme Special d'Energie
Planning and selection of projects not subject to systematic and rigorous evaluation; energy agenda partly donor driven	Establish clear procedures and criteria for assessing energy projects, involving the DGE and the National Commission	The DGE and the National Commission for Water and Energy	Technical assistance required for the preparation of procedures and criteria and for training of local staff. Cost: see above	To be carried out under proposed ESRP
REGIDESO in longtime need of being put on a sound operational and financial footing	Speed up the implementation of the existing reform plan, improvements in administrative procedures and financial structure	REGIDESO	Rehabilitation program incorporated in a performance contract to be implemented with the assistance of a foreign operator	Program initiated under a PPF advance and to be further financed under proposed ESRP and by other donors
New challenges and tasks for the Département des Forêts as focus shifts further towards agro-forestry	Adapt organization and strengthen capacity to plan and implement tasks related to changed focus	Département des Forêts	Technical assistance needed for planning and implementing the change, including training	Inclusion in next phase of Second Forestry Project proposed
Lack of systematic and overall approach to assess and alleviate environmental impacts of energy generation and supply	Design a national environmental strategy to provide general guidelines for environmental protection and management	Ministère de l'Aménagement, de l'Environnement et du Tourisme, and the DGE for ensuring that guidelines are applied to energy development	Technical assistance needed to prepare a national environmental strategy and assist with its implementation	The Government has indicated its interest in developing a strategy under a Special Project Preparation Facility

I. ENERGY AND THE ECONOMY

Background

1.1 Burundi is a small, landlocked country with a population of about 5 million. It has the second highest population density in Africa, a high population growth rate (3% p.a.), and its GNP per capita, estimated at about US$240 (1987), ranks among the lowest in the continent. The country has limited natural resources other than relatively fertile agricultural land. Agriculture is the dominant activity, contributing more than half of GDP, 93% of employment, and 85-90% of export earnings. The most important crop in this largely subsistence-dominated sector is coffee, which on average accounts for about 80% of export earnings. The secondary sector is small, accounting for about 13% of GDP and 10% of exports in recent years. As a landlocked country, Burundi is vulnerable to conditions in neighboring countries and faces very high transportation costs to and from the Indian Ocean ports.

1.2 In August 1988, Burundi experienced an outburst of ethnic violence which shook the country. Constructive action has been taken, however, by accelerating the policy of reconciliation and national unity. The overwhelming majority of the refugees have now returned to Burundi, and reconstruction efforts have been undertaken in the affected areas.

1.3 Burundi's major structural constraints are (a) high population growth, (b) excessive dependence on coffee exports, (c) excessive role of the public sector, and (d) inadequate incentives for sustained growth in agriculture and industry. In recognition of the serious economic consequences of failures to correct economic and financial imbalances, in 1985 the Government embarked on a comprehensive economic reform program which, however, was not carried out at the pace envisaged.

1.4 Despite political upheaval and wide and erratic coffee price changes, developments in the 1986-88 period were somewhat positive, following the recovery of agricultural production. GDP, on average, grew by about 3.5% per year over the 1986-88 period. In 1989, the agricultural sector performed poorly which was reflected in 0.4% growth of GDP; whereas coffee prices fell by 50% during the second part of the year after the International Coffee Organization (ICO) quota agreement collapsed. The balance of payments and public budget deficits were reduced during the 1987-89 period but rationalization of economic choice for public expenditure needs to be reinforced. The external financial situation, though still fragile, will remain secure in the medium-term due to a high reserve level and an expected disbursement from SAL II (second tranche).

1.5 Economic performance over the next five years will remain fragile and depend on several factors: (a) timely implementation of the adjustment program; (b) the responsiveness of the private sector to new incentives and the economic environment; (c) evolution of world prices for Burundi's exports, in particularly coffee; and (d) the availability of external financing on concessional terms. Assuming that aid inflows are sustained at the recent high levels, annual average real GDP growth for the 1990-94 period could be around 3-4% at market prices. Growth would originate essentially from the agricultural and the agro-industry sectors.

Energy Constraints on Economic Development

1.6 Burundi has so far been able to maintain a reasonably secure and uninterrupted supply of energy at prices which are not too much out of line with countries at a similar stage of economic development. In the case of petroleum, the underlying costs are high as a consequence of the country's landlocked position, but with a relatively mild taxation prices to consumers are not particularly high. Being entirely dependent on imports and long overland transportation of petroleum products through other countries the country is exposed to the threat of supply interrruptions for political and climatic reasons. These factors cause from time to time cuts in the supply but in recent years no major disruptions have occurred. Electricity is a special case, being available in the capital and major urban centers only due to the sparse pattern of settlement and low levels of income in rural areas. National hydropower resources are quite abundant but fairly costly to develop. The bulk of the country's use of energy is in wood and other biomass, most of which is not traded in commercial channels. Although data are scant, supply of fuelwood and charcoal appears to have been able to meet present demand both in rural and urban areas, and prices of marketed wood products have not risen in real terms in later years. At the rate of consumption of wood for (mainly) fuel purposes and with the clearing of land for agricultural purposes by a rapidly growing population this situation may, however, not last for very long. Wood consumption at present exceeds sustainable supply on a national level, and potential problems affecting the welfare of the rural population as well as the environment will be emerging unless determined action is taken.

1.7 So far, however, availability and cost of energy have not been a major constraint on economic development, except for the low penetration of electricity which may be a handicap of some significance to the development of industry and crafts outside urban centers and also an obstacle to the extension of social services (schools, hospitals, etc.). But, even though the situation so far is reasonably satisfactory, the rapid population growth and continued economic development give rise to important strategic challenges in all the major energy subsectors, i.e. wood and other biomass, petroleum, and electricity.

Sector Objectives and Strategies

1.8 In the Burundi energy sector, the main subsectors (wood and other biomass, petroleum, and electricity) are more clearly defined and less interwoven than is usually the case. Each supply subsector is closely associated with a well defined class of users. Broadly speaking, there is wood and biomass for households (including larger communal households in education, health service, and defense), petroleum for transport, electricity for industry and for electricity-specific purposes in other sectors where available. The full picture is certainly a bit more complex (households using kerosene or electricity for lighting and to a minimal extent kerosene for cooking; biomass and /or fuel oil for heat in industry, and so forth) but by and large, there are weak linkages and little overlap between subsectors. The limited scope for substitution between fuels for the provision of heat, which is the only major use technically open to substitution is brought out by the comparison of cost in terms of heat in Table 3.5 in Chapter III. The differences in cost per unit of useful energy are substantial.

1.9 The relative insignificance of intra-sectoral linkages simplifies the formulation and implementation of energy policies, in that the complicating requirement of dealing simultaneously with the whole energy sector can be somewhat relaxed, while the various energy issues can be forcefully dealt with within each one of the parallell subsectors. This allows more attention to be paid to energy's relation to other aspects, structural and economic, of the respective subsectors.

1.10 In the overwhelmingly dominant subsector, woodfuels and other biomass (over 90% of all energy use in Burundi), the strategy will aim at two equally important objectives: to assure the continued supply, and to increase the efficiency in the use of these energy sources. The rapid population growth (3% p.a.) lends urgency to both of these strategy components. Planting and growing of trees compete for land with food production and with settlement (housing, communal centers, etc.) for the growing population. The technical scope for improvements on the demand side (efficiency in use) and supply side is considerable, as will be seen in Chapter III, but the attainment of such improvement is as much a social as a technical process. Policies for the supply side will take due account of the fact that most of the production and procurement of wood and other biomass take place within a framework of subsistence farming, even though an increasing portion of this sector is gradually becoming monetised (supply to urban households, institutions, and industry).

1.11 The monetised (and still small) subdivision of the wood and biomass subsector comprises mainly charcoal and peat. Being monetised, this sector subdivision should be guided towards efficiency by market forces, but lack of information and a strategy for a rational use of the country wood resources seem to have delayed the development of sound market policies. Continued attention to these issued should be part of a biomass strategy.

1.12 In the petroleum subsector, reducing or at least holding down costs and assuring security of supply will be the main strategic issues, both rooted in the country's landlocked position. Long overland import routes, across several neighboring countries, give cause for technical as well as political security concerns while also adding a cost element of the same magnitude as the original world market cost of petroleum. The cost issue is exacerbated by the small quantities required, smaller than the normal quantities in world market trading.

1.13 The domestic issues in the petroleum subsector are relatively minor in importance, such as ensuring a cost-effective, reliable distribution of petroleum products to all localities in the country. The means to ensure this would be to promote the unhampered, efficient working of a retail market.

1.14 In the electricity subsector the main strategic objective, besides minimizing costs, would be to increase the availability of electricity from the present, very low penetration of only some 1.5% (in terms of share of the population served). Working against this objective is the settlement pattern of the country, with few and relatively small urban concentrations. The hydropower resource base of the country is good (see Chapter V), transmission distances are reasonable, but unit costs for transmission as well as for distribution come out high due to the low level of consumption. An important strategic challenge is to operate a tariff system that, while making minimum quantities of electricity available at affordable rates to target population categories, will encourage an efficient use of electricity at the margin and raise sufficient finance for the expansion of the system.

Energy Consumption

1.15 An energy balance for Burundi for 1988 is given in Table 1.1. The quality of the figures varies enormously and the uncertainty is particularly great with respect to the dominant sources of energy, biomass (see Annex 1.1); hence the pro forma character of the balance, the purpose of which is to illustrate in broad lines the movement of energy through the economy, the orders of magnitude and relative role of the various energies. This the balance does, even when allowing for margins of uncertainty as mentioned.

1.16 The estimated final consumption of energy, all sources combined, is 940,000 tons of oil equivalent (TOE), corresponding to 188 kgoe per inhabitant. Households consume more than 90% of all forms of energy combined, dwarfing the transport and industry sectors. The only energy import of significance is petroleum, accounting for 6% of final consumption. 1/ Reflecting the dominant role of agriculture in the economy and the low degree of urbanization, wood and other biomass cater for over 90% of the total energy consumption. Conversely, the low percentage accounted for by electricity (1%) and petroleum products (6%) reflects the early development stage of the monetized, industry-based economy. The weak intra-sectoral linkages are illustrated i.a. by the many empty boxes in the table. The only conversion of any significance is that from wood to charcoal. The present scope for interfuel substitution as already commented is very limited.

1.17 Commercial energy consumption (here: petroleum products and electricity) grew at an average annual rate of somewhat over 6% over the period 1980-88, considerably faster than GDP in constant prices during the same period (slightly less than 4% p.a.). Nonetheless, commercial energy consumption per capita and per unit of GDP remains lower than in other countries of similar size and income level in Africa (see Annex 1.2). The consumption of petroleum products alone increased by around 5% p.a. over the same period and the sale of electricity by close to 12% p.a. The latter rate was to a significant extent influenced by the addition of domestic hydropower capacity and the extension of the transmission and distribution network. As for woodfuels and other biomass forms of energy there are no data reliable enough to indicate the development of consumption in the past, except that one may assume that it has increased largely in the same proportion as the growth in population, which has been slightly less than 3% p.a. in the 1980s.

Energy Resources

1.18 In relation to the present level and pattern of energy demand, Burundi is reasonably well endowed in energy resources. The exception like for most other countries is petroleum, for which Burundi has to rely entirely on import. Although petroleum's share of overall energy use is small, that only reflects the correspondingly small share of transport and manufacturing in the economy.

1/ *Electricity imports, from the Ruzizi I power station in Zaire, accounted for some 10% of total electricity supply in 1988, or only 0.1% of total net energy supply in the energy balance.*

Table 1.1: BURUNDI ENERGY SUPPLY - DEMAND BALANCE - 1988
(1000 TOE)

	Agri. resid	Fuel-wood	Char-coal	Peat	Gaso-line	Diesel	Fuel oil	Kero-sene	LPG	Jetfuel Avgas	Elec-tricity	Total	%
Gross Supply													
Primary production	106.0	897.1		3.4							8.8	1,015.3	95
Imports					20.1	19.4	7.3	1.6	0.1	4.9	1.0	54.4	5
Total	106.0	897.1		3.4	20.1	19.4	7.3	1.6	0.1	4.9	9.8	1,069.7	100
Conversion													
Charcoal		(154.7)	154.7										
Electricity						(3.0)					3.0		
Conversion losses			(124.7)								(2.5)	(127.2)	
Transm. & distrib. losses					(0.2)	(0.2)	(0.1)	a/	a/	a/	(1.5)	(2.0)	
Net Supply	106.0	742.4	30.0	3.4	19.9	16.2	7.2	1.6	0.1	4.9	8.8	940.5	100
Consumption													
Households	106.0	724.8	30.0					1.5	0.1		2.8	865.2	92
Industry		7.5		0.7		3.7	7.2	0.1			3.6	22.8	2
Public services		10.1		2.7							2.4	15.2	2
Transport					19.9	12.5				4.9		37.3	4
% of net supply	11	79	3	0.3	2	2	1	0.2	b/	0.5	1	100	

a/ Quantity less than 50 TOE.
b/ Less than 0.1%.

Source: Electricity balance from REGIDESO.
Petroleum figures from Ministère du Commerce et de l'Industrie.
Peat figures from ONATOUR.
Other figures are mission estimates.

1.19 On the other hand, the country is rich in hydropower resources. The total hydropower potential is estimated to be about 6,000 GWh/year, of which 1,500 GWh/year is seen to be practically exploitable, from some 40 projects. Compared with current generation of 115 GWh/year (domestic and import, 1988), this would allow a 13-fold increase in supply, or enough to meet a 6 - 8% annual growth over 35-45 years. The limitation for the next few decades thus seems not to be in the resource base but in the economic and financial capacity for expanding the system. The country seems unlikely to have to import petroleum or coal for electricity generation.

1.20 Peat is a non-renewable source of energy found in large quantities in Burundi, in highland and lowland bogs. Highland bogs can cover demand at the present (modest) rate of 13,000 MT for more than 60 years. Peat resources in lowland bogs are much larger (estimated at 60 times those of highland bogs) but are unexploited today and can be developed economically only if demand increases significantly. The latter depends not only on costs but also on developing markets (uses) and improving the fuel product itself. Environmental aspects may also be a limiting factor to exploitation of peat on a larger scale.

1.21 The most complex and critical resource question is that related to wood and other biomass. While current production of fuelwood is estimated at 2.4 million MT/year the sustainable yield (annual increment) has been estimated at 1.7 million MT/year and the standing stock of trees at 40 million m3 (Chapter III). The current production may thus exceed the sustainable yield by some 0.7 million MT/year or by 2½% of the total standing stock. This might not be much cause for concern if a reduced consumption could be achieved in the future, if the ongoing production could be optimally distributed on all the standing stock, and if the estimates are correct. One serious mismatch is already apparent in the allocation of production as between industrial plantations and other forest resources. Industrial plantations are seen to yield more than 1.2 million MT/year on a sustainable basis against a total commercial offtake of 0.6 million MT/year. That leaves a yield of 0.5 million MT/year to meet the non-commercial offtake of 1.8 million MT/year. The standing stock from which this excess production (of 1.3 million MT or 2.0 million m3 annually) would be taken, amounts to some 15 million m3 (total stock minus industrial plantations). This stock is therefore at present being run down at a rate which already now gives cause for serious concern and again, since production is not ideally allocated on the whole stock, the resource depletion is even more severe locally.

1.22 This suggests a) that there could be a serious depletion problem with respect to important parts of the country's forest resources and b) that there is an urgent need for better and more comprehensive, quantitative information on these resources as well as their use.

Energy Projections

1.23 The development of energy demand in Burundi will depend on a number of socio-economic factors (demographic, urbanisation, economic growth, structural changes in the economy, etc.), on energy policy (in particular pricing policies, substitution and energy conservation measures), but also on funds available for investments and for imports that will increase the supply, particularly within the electricity sector. Information on past aggregate growth in energy consumption is not available and is

probably not a very meaningful basis for making projections since the energy sector from a consumption point of view is totally dominated by woodfuels for which reliable information is lacking. A breakdown by energy subsector should give a better basis for making a forecast that may be indicative of the proportions in the supply and demand for energy in year 2000. Except for the case of electricity (planning of new capacity), precision in projections is not decisive for policy issues. 2/

1.24 A reasonable assumption would be that demand for wood and other biomass would increase by 3-4% per annum over the medium term. This is somewhat higher than the projected population growth rate of 3% p.a., reflecting mainly the increasing use of charcoal and low degree of switching to modern fuels during this period of time. Efficiency measures with respect to consumption and production of woodfuels, as well as the impacts of possibly less easy access to wood, could modify this trend somewhat, but for the projected balance an aggregate growth rate for biomass of 3.6% p.a. is applied. The growth in electricity is determined to a large extent by the rate at which the supply system can be expanded. A growth rate of 6% is considered attainable, down from the rate during the major part of the last decade when expansion in already electrified urban areas was predominant and the first major domestic hydropower scheme came on stream. Demand for petroleum products, primarily for transport, is estimated to grow by some 5% per annum, mainly on the basis of expected increases in GDP and in population of the same order of magnitude as during the larger part of the '80s. No substantial additions to industrial capacity are anticipated. Projected demand is dealt with in more detail in the respective subsector chapters.

Table 1.2: PRIMARY ENERGY SUPPLY, 1988 AND 2000
(1,000 TOE)

	1988	Share %	2000	Share %	Growth rate %
Biomass	1,007	94	1,545	93	3.6
Petroleum products	53	5	93	6	4.8
Electricity	10	1	20	1	6.0
TOTAL	1,070	100	1,658	100	3.7

Source: Mission estimates.

1.25 Globally, total energy demand should increase by 3-4% p.a. until year 2000. The structure of demand as shown in Table 1.2 will still be heavily dominated by woodfuels and other biomass (93%) despite a doubling of the consumption of commercial fuels. In per capita terms, energy consumption increases to only a modest extent, to some 230 kgoe, in primary energy terms. The main reason for this relative stability in the consumption pattern is the expected lack of any major structural or dimensional changes in the Burundian economy or society in general before the turn of the century.

2/ *A recapitulation of some of the information given in previous paragraphs with some supplements may be useful. For the period 1980-88 the following average annual rates of increase were registered or are estimated: woodfuels and other biomass: 3%; electricity: 11%; petroleum products: 5%; GDP in real terms: 4%; population: 2.8%.*

1.26 Until now, relatively modest resources have been devoted to improving energy efficiency in Burundi. The main efforts have been the development and previous attempts at commercialization of improved woodfuel stoves for households and the development of more efficient carbonization methods. Although data are not available for Burundi, experience from other countries would indicate a theoretical potential for energy savings in the order of 10-15% of present actual consumption. Despite the fact that the return on activities and measures to conserve energy is generally found to be substantial, the transition from this theoretical potential to actual savings has proved difficult to attain on a broad scale. A conservation scenario based on more systematic and sustained energy conservation efforts, desirable as these may be, would not to any significant extent alter the basic proportions in an energy balance for year 2000 from that shown in Table 1.2.

Energy and the Commercial Balance

1.27 All petroleum products are imported from, or through, neighboring countries. Electricity originates mainly from domestic plants which, in 1988, accounted for 90% of the energy supplied, the balance being imported from Zaire. Under a protocole agreement between Burundi and Zaire from 1976, the former does not pay for electricity imports from the Ruzizi I power station (within certain quantity and time limits). Therefore, energy imports in Burundi's trade balance relate to the imports of petroleum products only. For the years 1986 to 1988, petroleum imports accounted for an average of 14% of merchandise imports and absorbed almost a quarter of the receipts from merchandise exports (see Table 1.3). Despite fairly significant increases in the quantity of petroleum products consumed, both the absolute value of petroleum imports and their relative importance vis-a-vis other imports have largely decreased or stagnated in the 1980s, due to the decrease in the world market price of petroleum during those years. This picture will be reversed if the price increases since August 1990 hold up.

1.28 Concerns for the balance of payments and a desire to reduce the country's dependence on imports in the interest of national security have contributed to efforts on the part of the Government to limit the fuel import bill. These concerns are reflected in the import duties and taxes on petroleum products and in the development of domestic hydroelectric resources despite the availability of low-cost power import alternatives.

Table 1.3: ENERGY AND THE COMMERCIAL BALANCE 1986-88
(BUF current millions)

	1986	1987	1988
Imports of petroleum products	3,259	3,740	3,804
Merchandise imports (CIF)	23,195	25,465	28,885
Merchandise exports (FOB)	14,744	12,151	17,459
Imports of petroleum as % of total imports	14.1	14.7	13.2
Imports of petroleum as % of total exports	22.1	30.8	21.8

Source: Banque de la République du Burundi: Rapport Annuel 1988.

Investments in the Energy Sector

1.29 Historically, energy has had a relatively small share of total public investments. This is not surprising given the dominance of agriculture in the economy. During the Fourth Five Year Development Plan, 1983-87, energy represented 11% of total public investments which was higher than during the preceding and the following plan periods. The investments in this sector grew at an average rate of 21% per annum during the years mentioned but growth rates for individual years fluctuated greatly, due to lumpiness of investments dominated by electricity projects. Energy represented 10% of total foreign-financed development expenditures for the 1983-87 period. For 1988 this figure was 8%. With regard to domestically financed development expenditures, the energy sector captured about 1% of total expenditure for the Fourth Plan period and remained at about the same level in 1988.

1.30 The Government's proposed investment program for the Fifth Five Year Development Plan, 1988-92, reduces energy's share of total investments to 3%, again with projects in the power subsector making up almost the entire energy sector program with 97% of BUF5.1 billion (US$32 million) of which approximately 80% will be represented by expenditures in foreign exchange. The reduction in percentage as well as in amount compared to the preceding plan period is due to the heavy investments in the Rwegura hydropower plant in the early part of the 1980s which alone absorbed about 70% of the sector investments. The Government investment plans are discussed in later subsector chapters.

II. ENERGY INSTITUTIONS AND PLANNING

Energy Institutions

2.1 The fundamentally different structures of the respective energy subsectors and their consequential distinct needs in planning and management are broadly reflected in the institutional framework for energy planning and management in Burundi. Planning, implementation and follow-up are generally carried out within each of the main subsectors, while the Direction Générale de l'Energie (DGE) of the Ministère de l'Energie et des Mines (MEM) is in principle responsible for overall planning, provides general guidelines and ensures coordination. Recently, a National Commission for Water and Energy has been created to oversee the national development and use of water and energy resources (see Annex 2.1 for a sector overview).

2.2 The structural characteristics that require different approaches in planning and management may perhaps best be illustrated by starting with the structurally fairly simple electricity sector. This sector provides a service in constantly supplying electricity from a system of fixed installations. The nature of the sector is that of a natural monopoly. Planning is highly technical, investments are large and have a long time horizon. The petroleum sector on the other hand is basically a commercial sector, in a regulated but competitive market. Operational logistics are important, investments are low (as long as production and refining are not involved). The wood and other biomass sector, which corresponds quite closely to the household energy sector, is maybe the most complex of the energy subsectors in that it ties in so closely with the household, farming and rural economy in general. These structural differences are naturally reflected in the institutional setup of the respective subsectors.

2.3 In the electricity sector, the REGIDESO (the water and electricity authority) is responsible for generation, transmission and distribution to urban areas, while the responsibility for rural areas is placed with the Direction Générale de l'Hydraulique et des Energies Rurales (DGHER) of the Ministère du Développement Rural et de l'Artisanat (MDR). REGIDESO is a parastatal organization, reporting to the Ministère de l'Energie et des Mines (MEM).

2.4 This division of responsibilities seems well justified. The two tasks, urban and rural electricity supply are rather distinct in character and call for different organizational approaches. The activities of an urban supply organization will evolve around the planning, construction and operation of a large integrated generation system and a transmssion and distribution grid. Rural electrification, insofar as it concerns areas that cannot be reached by the grid, means work on a large number of small, isolated schemes. The organization type of REGIDESO, although qualified in technical terms, might not be able to pay enough attention to these smaller schemes, at least unless a special department were created with sufficient motivation for that purpose. The DGHER on the other hand, being part of the Ministry for Rural Development, will have their attention focussed on the rural environment, and can integrate with other departments within the Ministry. The demarcation between the two agencies may however be a

problem, as pointed out in Chapter V, depending very much on how each of the agencies perceive the definition of urban versus rural. Some better guidelines should be established, along the lines suggested in Chapter V. The DGHER should also be able to contract technical services from the REGIDESO.

2.5 The REGIDESO is in the process of reforming its organization and procedures, to recover from serious operational and financial difficulties). Annual subsidies from the Government to the company now represent about 1% of the country's GDP. The improvement plan (Plan de Redressement) is carried out under an agreement with the World Bank within the framework of a Structural Adjustment Loan (for details, see Chapter V). Although at this stage priority must be given to urgent measures for increasing revenues and reducing operating costs, it is desirable, as the organization shapes up in those respects, that the management will also turn its attention to the agency's technical organization, to ensure adequate staffing and sufficient resources for planning, construction and technical operations. At present, staffing seems to be excessive in numbers, more than twice the normal number for this size of operation, the excess being mainly related to the distribution system. Training could raise the efficiency and reduce the number. The engineering staff needs to be strengthened, in particular with respect to maintenance which seems to get little or no attention.

2.6 In the petroleum sector, the central government agency is the Direction Générale du Commerce (DGC), in the Ministère du Commerce et de l'Industrie (MCI), but the ministries of Transport, Finance, and Planning are also to some degree involved. This would seem a logical arrangement, if regulating commercial activity in the sector were the overriding concern. What receives too little attention, though, is the adequacy of supply and the efficiency of the underlying supply arrangements.

2.7 As pointed out in Chapter IV, one of the critical issues is the coordination of petroleum product procurement so as to strengthen the bargaining position of Burundian importers in the international market. Another is to seek less costly and more reliably functioning alternative overland routes into Burundi. This would require the involvement of a more energy-focussed entity such as the Direction Générale de l'Energie, in parallel with other energy subsectors. A special unit for petroleum is therefore recommended to be established in the DGE, with sufficient professional capability and sufficient authority to address the supply issues as well as storage and distribution (see para. 4.50). Some staff and technical assistance with experience from international petroleum trade and from petroleum marketing would be needed. In purely commercial matters this unit would cooperate closely with the DGC. It should be pointed out, however, that many of the activities in the petroleum subsector are of a commercial nature, the import, wholesale and retail trade in petroleum products involving a number of participants in a competitive market context. The central interest of the Government should, in addition to securing supply, be to promote efficiency, and this is where DGE and others have a role. As an alternative to creating a new unit within DGE, consideration should be given to expanding the role of the Department des Projects (DP) and strengthening it as indicated above.

2.8 The dominant energy subsector in Burundi, wood and other biomass, is up against important challenges both on the supply side, to maintain the supply without seriously depleting the resource base, and on the demand side, to raise the generally very low efficiency in conversion (charcoal)

and in end use. On the supply side the central institution is the Département des Forêts (DF) of the Ministère de l'Aménagement, du Tourisme et de l'Environnement (MATE). The Département des Forêts is responsible also for promoting efficiency in charcoaling operations. For the considerable share of wood and biomass that is produced in integration with farming, responsibility is shared with the Ministère de l'Agriculture. To address the future challenges within the forestry subsector and, from an energy perspective, those related to the supply of woodfuels in particular, a review of the role and responsibilities of the DF is recommended, as discussed in Chapter III (para. 3.55). The staff of the DF, even when supplemented with externally financed technical assistance, is small considering the requirements and the urgency of its task and needs to be strengthened. In addition, it is proposed that the Département des Recherches et Statistiques, in the DGE, with certain responsibilities regarding alternative household technologies, be given a wider role within household energy planning and monitoring in general, whilst leaving the execution and implementation in broad terms with the present organizations (para. 3.57). As indicated by its name, the Ministère de l'Aménagement, du Tourisme et de l'Environnement furthermore oversees matters related to the environment and land development. Activities related to the environment in Burundi are monitored by departments within the Ministry, in cooperation with other ministries and departments.

2.9 The agency primarily responsible for the promotion of efficiency in end use of wood and other biomass is the Direction Générale de l'Hydraulique et de l'Energie Rurale. The DGHER, as its name indicates, is also responsible for rural electrification and for promotion of alternative energy sources (biogas, solar, wind). The problem of the agency is insufficiency in staff and resources. A large number of externally financed projects make important contributions to the work but also contribute to the fragmentation of the agency's activities.

2.10 The responsibility for the production and promotion of the use of peat is placed with the Office National de la Tourbe (ONATOUR), a parastatal company founded in 1977, and reporting to the MEM. ONATOUR's activities in developing end-use equipment and methods (stoves etc), to a considerable extent overlap with those of the DGHER. Transfer of these activities to CEBEA (Centre d'Etudes Burundais des Energies Alternatives) 3/ dealing with renewable energy technologies is being considered, allowing ONATOUR then to concentrate on production, promotion and marketing of peat.

2.11 In the field of new and renewable energies, overall responsibility is with two units of the DGE, the Département des Recherches et des Statistiques (DRS), and Centre d'Etudes Burundais des Energies Alternatives (CEBEA). In addition, DGHER is also involved as indicated above, through the implementation of projects.

2.12 In recognition of the benefits of regional cooperation, Burundi is also an active member in several organizations which promote regional energy development. The first of these is the energy affiliate of the Communauté Economique des Pays des Grands Lacs (CEPGL), known as the Organisation de la CEPGL pour l'Energie des Grands Lacs (EGL) which has had its role successively broadened to

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3/ In March 1990, responsibility for the activities of CEBEA were transferred to DRS pending a review of its activities within the household energy sector.

that of a regional institution covering the entire energy sector. In recent years, it has undertaken a variety of planning studies and pilot testing programs of new energy technologies, and it is also involved in improving coordination of power network operations. Furthermore, Burundi is a member of the Organisation pour l'Aménagement et le Développement du Bassin de la Rivière Kagera (OBK), created by a multi-government treaty to plan and execute projects, including energy sector projects, aimed at an integrated development of the Kagera Bassin region. Burundi is also a member of SINELAC, Société Internationale de l'Electricité des Pays des Grands Lacs.

Overall Policy, Coordination and Planning

2.13 The government agency responsible for the energy sector as a whole is the Direction Générale de l'Energie (DGE) in the Ministry of Energy and Mines, with its departments for Projects, and for Research and Statistics. A Department for Planning is now under consideration.

2.14 The organization of the DGE should reflect the structure of the agency's priority tasks. The foremost task is that of keeping an overview of the energy sector as a whole, assessing requirements and priorities as between subsectors, and giving general guidelines for subsector development. This requires a competent Planning Department, focussing on planning at the energy sector level, as a link between the country's overall economic planning and the physical, subsector planning which should be the responsibility of the respective subsector institutions. The Planning Department of the DGE would require a strong competence, particularly in economics. The DGE's activity in statistics, as an indispensable basis for planning, should be linked to the Planning Department. The DGE's activities in research would be concerned with technical research, in equipment and methods for better utilization of energy in particular related to households. The activities should be organized in the present Département des Recherches et Statistiques which should focus on research (and on the planning and monitoring of household energy in general, as mentioned earlier), shedding work on statistics to the new Planning Department. The role of the DGE's Project Department, concerned mainly with projects in the electricity subsector should be carefully considered to avoid duplication with subsector agencies as concerns physical planning. A particular case in point is planning by REGIDESO (see para. 2.18).

2.15 To summarize, it is recommended that the DGE be comprised of three sections, reporting to the Director General, compared to two today (see Annex 2.2): These would be the Planning Department, responsible for giving general guidelines for subsector development, the Project Department involved mainly in overall issues in the electricity and petroleum subsectors, and the Department for Research and Statistics monitoring development within household energy, including alternative technologies.

2.16 An important body is the recently created National Commission for Water and Energy, with sub-commissions for Water and for Energy. The main objective to be pursued by the Commission is to safeguard the water and energy resources and to promote their harmonious and rational utilization. The Commission will i.a. look after the coordination of action and the delimitation of responsibilities among the various institutions in the water and energy sectors. All the ministries involved in these sectors are represented on the commission and the respective sub-commission by their minister or his

deputy. Formally, the role of the Commission is consultative to the Government, but once the Commission's recommendations are approved by the Government, they will become official national policy.

2.17 In the initial stage, priority is given to establishing the Sub-commission on Energy, chaired by the General Director of Energy. The Secretariat of the National Commission for Water and Energy is provided by the DGE. The Commission should lend considerable authority to the DGE and ensure communication in important matters with the ministries involved.

2.18 It is essential that the DGE in its important coordinating role will support and strengthen the respective subsector institutions rather than duplicating or taking over their work. With the power and authority of the DGE, it may be tempting, when weaknesses are identified, to step in and take over the action. Except for emergency situations this would tend in the long run to weaken the subsector. The respective institutions need to be faced with the feedback from the results of their work. Weaknesses should be corrected by strengthening the institution involved and giving it more resources. A case in point is the REGIDESO which should be given full responsibility for planning the expansion of the electricity supply system, which today is done by the DGE.

2.19 Given the weak linkages between energy subsectors in Burundi, for which there are good reasons as commented in para. 1.9 above, management of the sector will be less concerned with coordinating the subsectors to each other and more with the balanced allocation of resources among them. Policy formulation will also be less concerned with the other energy subsectors and more with conditions in those economic sectors which the particular energy subsector serves (biomass with rural development and agriculture, electricity with urban and industrial development, etc.). A formal, top-down planning for an integrated energy sector, starting from the macro level (as proposed for instance by the Energie des Grands Lacs) will hardly be effective, as it rarely is, even in mature economies with strong linkages among sectors.

2.20 Ideally, coordination in a decentralized system would be achieved by establishing uniform investment criteria for linking up with the demand side. With the great dissimilarity between energy subsectors (viz electricity dominated by clearly identifiable projects, the wood and biomass subsector more by ongoing programs and externally financed technical assistance) the use of formal, objective criteria may not always be possible. Setting of priorities may call for judgement by the DGE. In important cases the possibility of referral to the Commission may be very helpful.

2.21 A special problem in coordination is presented by the considerable number of externally financed projects. This may easily translate into a donor driven energy agenda, something which is the case in Burundi. Investment plans for the energy sector are not prepared in a coherent and systematic manner and the application of accepted economic criteria for selecting projects is limited. Offers by external donors for financial and technical assistance for a particular project may thus prevail over relevance with respect to national objectives and priorities. Insofar as there is a donor interest in supporting projects in "energy" the DGE and the Commission should be the agencies best suited for directing such project support to where it is most useful. The DGE Planning Department should be

responsible for assessing the relative merits of all such projects based on a more rigorous approach to project selection, recommending possible amendments, and keeping track of their implementation.

2.22 In the externally financed Programme Spécial d'Energie (PSE) the DGE seems to have an efficient instrument for helping to establish a structured approach to energy issues involving many different entities, more specifically, the issue of rural energy with particular emphasis on new and renewable energies. On the whole, where direct support from the DGE would be most needed is in the rural energy sector. DGE should be well placed to take a strong lead in work on the demand side, improving technologies and methods for better energy use - i.a. by cordinating the many donor activities in this area - while taking care not to release other agencies, DGHER, DF, etc., from their responsibilities on the supply side.

Recommendations

2.23 The main recommendations and conclusions related to institutional matters are:

(a) The Direction Générale de l'Energie should have macro-level planning at the general energy sector level as its primary task, overseeing and giving priorities and guidelines for the respective subsector agencies. Physical planning for individual subsectors should be the responsibility of the subsector agency, supervised by the DGE. A Department for Planning in the DGE now being considered should be established as soon as possible;

(b) Clear procedures and generally accepted investment criteria to be applied for evaluating projects and programs in the individual energy subsectors need to be elaborated by the Planning Department which also will have an important role of ensuring that these procedures and criteria are applied by the subsector agencies. The acceptance of externally financed projects in the energy sector should be subject to assessment and recommendation by the DGE;

(c) An adequate capability for physical planning should be urgently established in REGIDESO and the DGE Planning Department should reduce its involvement correspondingly. The delimitation of responsibilities in rural electrification between the DGHER and REGIDESO should be clarified, along the lines suggested in Chapter V;

(d) The DGE should have the responsibility for addressing petroleum supply and demand issues (procurement, transport, storage and pricing) as dealt with in Chapter IV, with the Ministère du Commerce et de l'Industrie continuing to focus on the commercial matters. To avoid creating a new unit, consideration should be given to assigning this role to the present Project Department; and

(e) The role of the Département des Forêts should be redefined to meet new challenges, and the DRS should be given broader responsibilities with respect to overall planning and monitoring of household energy and renewable technologies. These issues are dealt with in Chapter III.

2.24 In conclusion, the picture with respect to institutional efficiency in the energy sector is, as might be expected, a varied one. This is, as indicated above, due both to weaknesses within the organizations and to lack of clarity as to specific responsibilities among the institutions involved. However, a firming up of the institutional structure as recommended, particularly the planning activity of the DGE in general, a more integrated approach to household energy and petroleum supply issues, and the activity of the National Commission, should contribute to the setting of clearer priorities and clearer plans for action in the energy sector. Sector level improvements need to be complemented by specific measures to improve performance by the subsector institutions, as proposed in later chapters.

2.25 The indicated reorientation of the DGE will require the addition of a small number of highly qualified key professionals doing economic and technical analysis and some specialized staff in charge of operating data bases. For the Planning Department this would mean 2-3 persons with a technical - but even more important - a strong economic background. In the establishment phase, external assistance would be required. Furthermore, the Project Department would need to hire and train two nationals who would be assisted in the early phases by an international petroleum expert and a pricing/fiscal economist, as indicated in Chapter IV. The Department for Research and Statistics would require 2-3 persons with a good background in household energy issues and energy data base and surveys (see Chapter III).

III. BIOMASS AND HOUSEHOLD ENERGY

Background

3.1 The biomass and household energy scene has not changed much during the 1980's since the first Energy Assessment. Wood remains the primary source of energy (more than 80% of total energy consumption). Deforestation continues to occur locally, but the extent has never been determined due to a lack of reliable data on woody biomass resources. To alleviate the perceived problems of local deforestation and to safeguard the supply of woodfuels in the future, a considerable number of industrial wood plantations have been established through Government and donor financed projects around major urban areas, and a system of rural nurseries has been launched providing seedlings to farmers for individual woodlots.

3.2 It is clear that woodfuels will remain the main source of household energy for several decades since the situation combining high costs of imported fuel and low purchasing power of the population is not likely to change fundamentally in the medium term. The main thrust of the household energy sector policy should therefore focus more on ensuring the availability of sustainable wood supplies and efficiency improvements than on any large scale substitution for woodfuels. It is also evident that the actual supply and consumption of woodfuels need to be known more accurately than is currently the case: large gaps exist in both resource and consumption data. Improvements are required in order to develop a well-founded household energy strategy. More and better information is also necessary to determine to what extent the cutting of trees for fuel is responsible for deforestation and environmental degradation.

Government Objectives and Policies

3.3 There is no explicit government policy for the household energy sector as such, to set priorities and give guidelines for the activities undertaken to meet the needs for energy in the households. The Fifth Five Year Development Plan, 1988-1992, and the policy document, "Politique Sectorielle du Ministère de l'Energie et des Mines" from 1989, describe the objectives with respect to the supply of energy in rural areas (where more than 90% of the population lives), acknowledge the dependance of the population on woodfuels, and emphasize the need to promote substitution and conservation. The objectives and recommendations are couched in general terms, however, are based on limited analyses of the issues involved, but except maybe for the regional planning activities of PSE in Gitega, they do not translate into coherent and concrete policies and programs. Ongoing projects and operations within the sector, covering different types of fuels are to a large extent donor driven and appear not to reflect conscious setting of priorities.

3.4 For the country's main source of energy, wood, however, the Government has adopted a forestry policy, as a basis for the large afforestation programs which have been implemented over the last decade or so. The Government's long-term forestry sector objective is the restitution of tree cover on 20% of the total land area, equivalent to some 550,000 ha of forest and woodland, compared to a

rough estimate of present tree coverage of 7%. The adopted strategy is to (a) protect and manage the remaining 42,000 ha of degraded dense mountain forests and 15,000 ha of savannah woodlands; (b) establish new plantations through departmental and communal activities; and (c) promote private tree planting through agroforestry and through individual or collective planting around the households of fuelwood and fruit trees.

3.5 In practice, reforestation mainly through industrial wood plantations has been the principal thrust of past efforts to improve the wood energy demand/supply balance. The impact of these plantations on fuelwood supply has been limited by their inaccessibility and the high costs of wood compared to market prices (see para. 3.27).

Current Pattern and Level of Household Energy Consumption

3.6 Most of the household energy demand is for cooking and is mainly met by woodfuels. Other energy demands are for lighting, ironing, refrigeration, and for operating certain various small appliances, which are met with petroleum products, modest quantities of publicly supplied electricity and by batteries. Home heating does not play a major role in Burundi except in certain high altitude areas. The choice of cooking fuel is mainly determined by the user's income level, habits and location, with a predominance of charcoal in urban areas and firewood in rural areas.

3.7 Table 3.1 shows the level and structure of household energy consumption in Burundi in 1988. Furthermore, projections are made up to year 2000. The figures are given in original units (MT, GWh), in primary energy terms (conversion efficiency of charcoal production and electricity generation included), as well as in energy end use terms. There is a lack of reliable data, and current consumption and projections in this report are based on estimates by the Département des Recherches et Statistiques (DRS) and the mission (see Annex 3.1). Just as was the case at the time of the previous energy assessment in 1982, the present mission concludes that there is a clear need for improvements with respect to data on energy consumption and recommends a household energy survey (see para. 3.18).

3.8 In primary energy terms, overall household energy consumption is at present 1 million TOE. Of this total, fuelwood (73%), charcoal (16%, but only 3.5% measured in end-use) and agricultural residues (11%) cover 99% of the energy needs of households, the balance being met by electricity and kerosene in minimal quantities. This pattern is well known from other African countries.

3.9 Total wood consumption for energy purposes amounts to around 2.4 million MT per year and is almost entirely accounted for by households (98%), the balance being used by industry and institutions. 4/ In primary energy terms, close to a quarter of the woodfuel consumed is estimated to be purchased and the remainder collected. A distinction between commercial woodfuels and collected woodfuels is made since the likelihood that woodfuels consumption have a negative impact on the

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4/ *Wood consumption for energy purposes by other users (in 1988 estimated at less than 50,000 MT), although dwarfed by household consumption (2,335,000 MT), is included since it is total wood consumption for energy purposes that later in the report is compared to sustainable supply.*

environment is much larger for commercial than for collected woodfuels due to the intensive tree felling frequently associated with charcoal production, etc. The share of woodfuel that is commercialized also indicates the extent to which demand management through the use of the price mechanism and taxation is likely to have an effect on wood use and wood felling.

Table 3.1: HOUSEHOLD ENERGY CONSUMPTION

	1988	Share (%)	1995 a/	2000 a/	Share (%)
Energy consumption (in original units) b/					
Wood (000 MT)	1,925 c/		2,326	2,642	
Charcoal "	41 c/		67	98	
Agricultural residues "	322		392	452	
Peat "	0		0	0	
Kerosene "	1		2	2	
LPG d/ "	0		0	0	
Electricity (GWh)	22		33	47	
Energy end use (TOE)					
Wood	724,847	83.8	875,671	994,471	81.4
Charcoal	29,953	3.5	48,847	71,341	5.9
Agricultural residues	106,000	12.3	129,294	148,918	12.2
Peat	0	0	0	0	0
Kerosene	1,459	0.2	1,788	2,071	0.2
LPG	141	0	212	259	0
Electricity	1,859	0.2	2,824	3,976	0.3
Total	864,259	100	1,058,636	1,221,036	100
Primary energy (TOE)					
Wood	724,847	73.0	875,671	994,471	65.2
Wood for charcoal e/	154,635	15.6	252,165	368,212	24.1
Agricultural residues	106,000	10.7	129,294	148,918	9.8
Peat	0	0	0	0	0
Kerosene	1,459	0.1	1,788	2,071	0.1
LPG	141	0	212	259	0
Electricity f/	5,482	0.6	8,329	11,694	0.8
Total	992,564	100	1,267,459	1,525,625	100

a/ For assumptions regarding projections see notes to Table 3 in Annex 3.1.
b/ Shares not applicable.
c/ Total wood consumption of households before conversion into charcoal was 2,335,000 MT, to which the use of wood for energy purposes by industry and institutions may be added, 47,000 MT, giving a total of close to 2,400,000 MT (see Appendix 3.1).
d/ Consumption less than 500 MT.
e/ Charcoal production efficiency: 10%.
f/ Power generation efficiency: 34%.

Source: DRS; mission estimates.

Projected Household Energy Consumption

3.10 Household energy consumption has been projected up to year 2000 using present consumption patterns and the trends in population growth (overall rate for Burundi 3%) as the main parameters. 5/ Consumption is estimated to increase to some 1.5 million TOE in primary terms by year 2000, or by roughly 50% over present national demand (see Table 3.1). This corresponds to an increase of 3.6% p.a. Over the medium term, modern fuels will continue to play a negligible role for the vast majority of households for reasons related both to the demand side (income level and other socio-economic factors) and the supply side (low level of rural electrification and the general availability of "free" wood). Woodfuels and other biomass will continue to dominate the overall picture, with charcoal increasing its share quite significantly due to the combined effect of higher increase in urban population and a switching among this population group towards charcoal as a preferred fuel and away from firewood. More details on the assumptions are given in Annex 3.1.

3.11 The continued reliance on wood and increasing demand for woodfuels as the population grows, point to this source of energy as the m[illegible] target for measures aimed at increasing supply as well as improving efficiency in production and use. The increasing proportion of charcoal in the woodfuel mix makes this fuel the prime candidate for conservation efforts. In terms of user groups, urban households together with small-scale industry and institutions using commercialized woodfuels merit particular attention.

Biomass Resources and Production

3.12 The need for new agricultural land, coupled with the demand for woodfuels and timber, have drastically reduced the land area occupied by natural forests. The total surface area of forests, woodland savannah and tree plantations, in Burundi now represents only some 200,000 ha. Roughly 135,000 ha of these forests are man-made plantations, while 60,000 ha are protected forests and other woodlands, including the remnants of dense tropical mountain forest along the Zaire-Nile crest divide in the northwest and forest galleries along water courses and steep gorges.

3.13 Table 3.2 provides an overview of the estimated acreage, the standing stock and the wood production capacity in the different types of plantations and forests. Private and public plantations account for 3/4 of the annual increment in standing stock, the high yields reflecting good soil conditions and adequate rainfall. Most of the wood that is actually commercialized is reportedly coming from private plantations. The large-scale public plantations are mainly located in the western part of the country, as shown on the map in the back of the report. Only about 5% of the annual regeneration of

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5/ *A scenario where the consumption rate of wood increases exponentially with population growth is based, inter alia, on continued availability and ease of access to wood. In reality, woodfuel consumption is not a static variable that can simply be extrapolated from population growth rates. Should fuelwood become scarce, real costs and prices would rise, and people would normally turn to substitutes or otherwise try to reduce consumption. This would modify the presented demand forecast accordingly. At present, the amount and quality of information with respect to availability of wood and consumer reactions to scarcity in Burundi preclude any further elaboration of the forecast.*

the country's wood takes place in natural forests from which it is illegal to collect wood but which nevertheless serve as a source of supply. The arborizations 6/ contribute around 10% of the incremental growth. With the exception of public plantations, all figures on surfaces, standing stock and yields are very uncertain.

Table 3.2: BURUNDI: ESTIMATED WOOD PRODUCTION CAPACITY (1988)

	Surface	Standing Stock		
Increment 1000 1000	ha	1000 m3	m3/yr	MT/yr
Natural Forests	56,700	5,670	113	79
Village Forests	12,300	738	49	32
Forestry Department	9,140	1,371	73	48
Project Plantations	45,840	10,314	917	596
Savannahs	300,000	4,500	150	105
SRD	8,510	681	51	28
Private plantations	61,000	12,200	915	595
Arborization	500,000	2,500	250	163
Nude	278,340	0	0	0
Agriculture	1,455,900	1,456	87	57
Urban	55,670	28	3	2
Total	2,783,400	39,458	2,608	1,705

Assumptions: See Annex 3.2

Source: Mission estimates, DF.

Woodfuels Balance

3.14 The total present sustainable supply of wood, 1.7 million MT per year, as seen in Table 3.2, is about 70-75% of annual demand, 2.4 million MT (para. 3.9). The first figure may be somewhat conservative but on the other hand a part (5%) of the increment is represented by wood from natural forests which are protected. In addition, it is difficult to distinguish between accessible and inaccessible sources. The latter applies to forested land and tree-savannah areas included in the table but too remote from the more populated areas, or simply too costly or difficult to exploit. In practice, inaccessibility reduces the quantity of wood available for energy and other uses.

3.15 The volume of wood at present demanded over and above total sustainable supply amounts to approximately 2.5% annually of the total standing stock. Since consumption in Burundi is assumed to be increasing at a rate slightly higher than population growth, while the mean annual increment from existing stocks is declining in direct proportion to the decline in the stocks, both the annual increment and the stocks would appear to be declining at accelerating rates. What such a development will lead to over some time, say up to year 2000, is difficult to say with the present shortage of reliable data, and also because certain forces come into play that modify the tendencies that are observed at lower level of shortage. For illustrative purposes, some calculations have been made in Annex 3.3 with respect to tree

6/ *Trees scattered in a farmer's field.*

stocks and yields in Burundi if present trends continue unchecked. They show alarming decreases in resources and supply over the medium term. Tree stock could be down to 1/3 of present level and consumption could be 6 times mean annual increment of wood by year 2000. The "mechanistic" and in a way extrapolative character of the calculations and assumptions should be emphasized, however.

3.16 Nevertheless, to sum up, three observations are appropriate:

(a) a depletion of wood resources appears to be taking place at present on a national level in Burundi;

(b) data and information are lacking or of low reliability, meaning that remedial action will have to be taken despite the high degree of uncertainty;

(c) measures to improve both the woodfuel balance and the level of information must be taken immediately and in parallel in those zones where the most serious ecological problems occur since they take time to become effective and deforestation must be checked as soon as possible (see below).

3.17 Some additional comments related to the woodfuels situation in Burundi are warranted:

(a) in the early stages of wood resource depletion the impacts on supply and prices of fuelwoods are hardly noticeable. This is the case also in Burundi where, for instance, charcoal prices have been stable over the last 3-4 years and therefore do not yet convey any signals of approaching shortages. In addition, it should be mentioned that only 20-25% of wood for fuel in Burundi is commercialized, which means that trends in market prices alone cannot be relied upon to fully express developing scarcity;

(b) as the timber resources are progressively "mined" and wood becomes scarcer, costs increase and measures initiated by the users and/or the authorities will generally be applied to conserve or substitute wood. It should be kept in mind, however, that modern fuel substitutes in Burundi are relatively expensive and rural incomes are very low which effectively limits a switch from woodfuels (see also para. 3.41);

(c) clearance of trees for agricultural purposes due to population pressure are not included in the wood consumption figures referred to above, nor has wood use for other ends than energy, such as for poles and construction, estimated at 5-10% of total wood consumption, been accounted for; and

(d) finally, the picture drawn above is for the country as a whole. There will be local variations with higher and lower rates of wood cutting, higher particularly around urban centers, with consequences for the local supply/demand balance and for the environment. Chapter VIII discusses the environmental impacts of fuelwood supply and use in Burundi.

3.18 As a result of the conclusions drawn in para 3.16, it is recommended that measures are taken as soon as possible to improve the level and quality of information (a) with respect to resources and production of wildfowls, on the one hand and, (b) the demand for these fuels and household fuels in general, on the other. Far better data on wood resources and yields from public as well as private sources are needed, as are the sources and channels through which the supply of commercial wood - and charcoal, in particular - passes, i.e. the formal and informal organization of this subsector needs to be studied. Information on the largest group of consumers of energy in Burundi, the households, is also quite inadequate. Therefore, a household energy survey should be carried out to develop a realistic database on household energy use. Together, improved information on the resource and demand side, and a discussion between potential users and producers of wood would permit the formulation of a long-term woodfuel supply policy and a household energy strategy, and establish a proper basis for planning purposes and a system for monitoring changes. Outlines of the main elements of the inventory of wood resources and of the household energy consumption survey is given in Annex 3.4 and 3.5, respectively, together with preliminary budgets of US$700,000 and US$170,000. The Government of Burundi is at present preparing funding requests.

3.19 In addition, and pending the outcome of the studies, the mission recommends that the present policies with respect to afforestation be reviewed and modifications be introduced. These should reflect the present situation where shortages and local deforestation appear to be the result not so much of commercial woodfuel requirements, which reportedly are covered primarily by private plantations, but rather related to pressure on resources connected with the use of wood by individual households as well as to the clearing of forested areas for agricultural purposes. The policy to be reinforced in the near term should therefore focus on wood planting on homesteads and on other private land, as well as on pursuing demand management and other efficiency-related measures. These aspects are discussed in more detail in the following sections.

Measures to Strengthen Wood Supply

3.20 Two main investment options exist to increase the wood supply: establishing plantations (public, village and private), and promoting agro-forestry and arborization. In addition, proper management of existing resources represents a sub-option that aims at increasing the impact that, for instance, present plantations may have on the supply of commercial wood.

3.21 Since the late 1970s, the focus has been on issues prompted largely by evidence that forest resources were being cut down much faster than they were replaced. This led to an investment program which has been quite successful in stepping up the rate of plantations established, protecting natural forests and launching a nursery program to supply seedling to farmers for individual woodlots. These were elements of the First Forestry Project funded by the Bank and approved in 1978. The on-going Second Forestry Project, approved in 1985, pursues strategies adopted under the first project to further strengthen basic forestry services and expand plantations supplying woodfuel, building poles and timber, including more specifically the establishment of additional nurseries, development of short-rotation eucalyptus plantations, and development of pine plantations.

3.22 However, a need to pursue the shift of focus from commercial plantations to a stronger promotion of agroforestry and arborisation is becoming increasingly apparent, for several reasons. Comparing present and projected demand for commercial woodfuel (at present, less than 600,000 MT/year, in year 2000, 1.1-1.2 mill. MT) with total yield from existing plantations (1.3 mill. MT), which are the main sources of marketed woodfuels, indicates that aggregate plantation capacity is more than sufficient. This conclusion seems to hold for the medium term up to year 2000 and it cautions against new fuelwood plantation programs in general.

3.23 Furthermore, the sheer magnitude of the potential gap between future aggregate demand for wood and sustainable supply discussed in the section on Woodfuels Balance requires measures that are geared towards increasing wood resources on a large scale, which points to a different approach than the relatively investment -, labor - and land intensive plantation strategy. The contribution of plantations remains low, relatively speaking, on account of the relatively small areas that can be planted given the population's demand for available land for agricultural purposes. In fact, Burundi's critical land shortage places a serious question mark at large plantation programs as an option in the future. The budgetary problems and the wage-labor requirements of the forestry service also limits the amount of planting that can be done and the extent to which new plantations can be protected and maintained. The potential contribution to output of agro-forestry, on the other hand, is large on account of the much larger areas that can be planted both by increasing densities of trees on farm land and by the availability of labor input by rural households which are orders of magnitude larger than the number of foresters and technicians in Burundi. By the same token, planting of large number of trees over large areas, as compared to the concentrated plantings over relatively small areas of the plantation approach, implies that the ecological benefits of increased wood coverage are both more extensive and better distributed over farm lands. 7/

3.24 In addition, the unit costs of agro-forestry programs are considerably lower than those of plantation projects (reported in some other countries to be of the order of 10-20% of the costs of the latter). This enhances the case for these programs, since the public budgetary commitments, and thus the financial risks, are comparatively low while the prospective economic and financial returns to investments in agro-forestry, as shown by experience elsewhere, are likely to be large. To be effective, however, such programs have to be carefully designed, must include the necessary incentives to the farmers and provide them with adequate support. The response of the farmers is of crucial importance. Experience in Burundi from the two forestry projects indicates that farmers are keen to grow trees for their own needs and that they are willing and ready to purchase seedlings.

3.25 Rural nurseries have, as indicated above, been established in Burundi by the Département des Forêts (DF) under several projects (see Annex 3.6 for Household Energy Projects). These nurseries sell seedling to farmers, villages, etc., for a subsidized price of BUF 2 per plant for fuelwood species

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7/ *A different option for overcoming the land availability constraint is to utilize poor mountain-ridge land with little or no agricultural potential for tree planting, which will have substantial environmental benefits as well. This technique is currently applied to improve important watersheds of the Zaire and Nile Rivers. Although the mean annual increment of these protection plantations will be low, so is the opportunity cost of the land, and there would be environmental as well as fuelwood supply benefits.*

and BUF 3 for timber species, while production costs are BUF 5-6 per plant. The World Bank/Fonds d'aide et de cooperation project alone produced a total of 3.6 million plants during the 1988/89 season from 91 nurseries with a capacity of 30,000-40,000 plants each. Nearly half of the plants that year were planted for demonstration purposes in village plantations, a quarter were sold to private farmers and the rest were reportedly lost. No cost-benefit analysis of the agro-forestry approach has been carried out specifically in Burundi, but experience from other countries is, as indicated, positive if the projects are properly designed and monitored, which appears to be the case in Burundi.

3.26 For the reasons mentioned above, therefore, the mission recommends that reforestation efforts emphasize agro-forestry and that the establishment of new plantations be limited to highly specific cases related to local urban needs for commercial wood, with clear demonstration of environmental benefits based on the users paying the real cost of wood. A change of focus of the reforestation program, however, has institutional implications for the DF and necessitates strengthening of the functions associated with agro-foresty, including a decentralized nursery and seedling distribution system, a reinforcement of extension services and project monitoring system, and further research and experimental work as well as pilot implementation programs (see para. 3.55).

Existing Plantations

3.27 Several industrial wood plantations established by the Government in cooperation with donor organizations are located around Bujumbura, at distances of 30-60 km from the capital. The present phase of the projects has as a mandate to grow wood, not commercialize it, which was envisaged for the next phase. As the trees have grown faster than expected, the lack of proper plans and organization for commercialization of the wood leads to an underutilization of the resources. In addition, at the outset of the projects no real market study of the need for wood was carried out, and the potential of the private plantations which are the main suppliers to Bujumbura was not properly considered. The plantations could potentially create a surplus of commercial wood aimed at urban households, cottage industry and institutions when reaching maturity. It is difficult for the industrial plantations to compete with the private sector, however, not only because they in practice prove more costly to develop, operate and maintain, but also because the access to them is difficult. The roads leading to some of these plantations are inaccessible except for small 4x4 vehicles, which makes it difficult and costly for transporters to buy wood and woodfuels at these locations.

3.28 The industrial plantations as such are well managed under the ongoing projects (as evidenced i.a. by the faster than anticipated growth), but as they reach maturity they are to be handed over to the DF. This institution is not properly set up to handle the commercialization of wood which is important if these are to make the anticipated contribution to the wood supply. The private sector, on the other hand, has proved its capability in this area. It is therefore recommended that proper consideration be given to letting private interests operate and maintain the plantations in question and commercialize the wood from them, on a sustainable basis, by inviting bids for long-term concessions. The interest from the private sector would be a good indicator of the contribution the plantations could make towards the wood supply. Prior to that, however, it is necessary to: (a) develop plans for the use and marketing of wood from public plantations where due consideration is given to the supply from existing private plantations; (b) review cost and pricing aspects of commercialized wood (see para. 3.49); and (c) provide proper access to the plantations by building roads in those cases where the benefits of

making plantations more accessible are estimated to exceed the costs. It is recommended that these steps, including preparations for an involvement of the private sector, be taken as part of the finalization of the projects responsible for the plantations, in particular by the Second Forestry Project.

Woodfuel Conservation

3.29 Stoves. Consumption of wildfowls in traditional stoves is quite inefficient and considerable scope for improvements exists. Wood in rural areas is consumed in 3-stone open fires (or 2 positioned against the wall), with an estimated efficiency of 10-15%. Charcoal consumption in urban areas takes place in traditional metal charcoal stoves (Imbabura) which are used in the open air, with an estimated efficiency of less than 20%. Several programs exist aiming at improving efficiency of woodfuel use.

3.30 Improved stoves for the rural areas is the focus of a Chinese aid program to Burundi. Several other programs or projects have also looked into the issue of improved efficiency of these types of stoves, among them the Bank's First Forestry Project and UNICEF, but they have all abandoned stove operations. The focus of the Chinese project is on research of fixed, owner-constructed stoves, the construction cost of which has been reduced from BUF 7700 to BUF 1200. Not surprisingly, there is still no market among households for a stove at this cost, as they currently pay nothing for their fuel nor for their current cooking stoves. At present, less than 10 stoves have been installed around Gitega and the Imbo Plain, monitored in cooperation with the Ministère de Développement Rural (MDR).

3.31 Improved charcoal stoves (Ziganya) in urban areas are promoted by ONATOUR (started in 1985 by the DUB project (Developpement Urbain de Bujumbura) and transferred to ONATOUR in 1989). A total of 15,000 stoves have been sold in Bujumbura since 1985 which is equivalent to approximately 10% of the number of charcoal-using households in the city. The stoves are produced by artisans from scrap metal and sold by the project as well as through several small shops and market places. Imbaburas are sold for BUF 75-120 while improved stoves sell for BUF 250-350. A Ziganya saves more than 30% charcoal compared to the traditional Imbabura as measured through a number of surveys (a limited number of households during prolonged testing periods).

3.32 Even though these high charcoal savings imply a payback time of half a month, 8/ the higher purchase price of the improved stoves is the major problem as perceived by the households. At one time, in 1987, some 600-900 stoves were sold monthly in Bujumbura, but sales are now about 400/month. There has been a lack of follow-up of the project and little interest on the part of the Government. To a certain extent this also applies to ONATOUR, the present promoter, which feels that this project is outside their main line of activity. The stove model is not found in other countries, mainly because Burundian households prefer larger stove models. It has a small fire box in a larger housing,

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8/ *Bujumbura: Average daily household consumption of charcoal among charcoal-using households: 2.4 kg. Price (lower range): BUF 15/kg. Monthly household expenditure on charcoal (low estimate): BUF 1,000. Monthly charcoal savings by using improved stove: BUF 400. Additional average purchase cost of improved stove vs. traditional stove: BUF 200.*

which results in a relatively quick deterioration of the outer housing of the stove: its lifetime has been found to be 6-12 months, which still is double that of the Imbabura. There is no easy solution to the dilemma of lifetime and price, as higher quality metal will increase its retail price further and a different model is not offhand acceptable to the households. Finally, there is a problem of how best to organize the artisans, i.e. how to provide proper financial and other incentives to them in order to make them focus more on the production of the improved stoves as opposed to the traditional ones for which there is a lucrative market. 9/

3.33 Although there is a need for a more stringent quality control, the main issues to address appear to be of an institutional nature, on several levels. The Government has to acknowledge its responsibility and provide the necessary backing to a project which not only from its potential for saving charcoal, the consumption of which - as shown earlier - is expected to grow considerably, but also from a cost and technical point of view merits increased support. The aim, however, is to make the production and sale of improved stoves a commercially viable activity that is taken over by the private sector, not only in Bujumbura but also in secondary towns. Until it reaches that stage, the Government needs to be involved, but not necessarily through ONATOUR which is not the best suited organization for this purpose. The latter has agreed to continue to manage the project until the end of 1990, however, whereafter it will be placed at the Direction Générale de la Promotion Féminine et Protection Sociale.

3.34 Before the private sector can be expected to take over production and sales of the new stoves, the following main activities are recommended carried out by the public organization:

(a) training and organizing of local artisans in the production of improved stoves;

(b) identification of suitable organizations in the private sector to sell and distribute stoves;

(c) carrying out certain surveys; and

(d) preparations for the commercialization of improved stoves, including publicity campaigns.

The organization responsible for this work will need to be strengthened with two persons with the right combination of technical and entrepreneurial background to assist the project, including the public awareness campaign. It is recommended that such persons be hired as soon as possible. A project outline and a budget of US$315,000 for the above mentioned activities is provided on Annex 3.7.

3.35 Charcoal Production. Inefficient charcoal making is a serious problem as much wood is wasted in its production. Most charcoal is produced and marketed by small scale entrepreneurs. Wood

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9/ *The population of Bujumbura consists of 266,000 inhabitants, or approximately 44,300 households of which 85% use charcoal. This means 37,700 households who all have approximately two stoves. Traditional stoves last between 3 and 6 months, so a conservative estimate of the total market is: 2(stoves/household) x 2(stoves/year) x 37,700(households) = 150,000 stoves/year.*

is cut and charcoal produced in situ. Production techniques employed are exclusively traditional (burning in earthen mounts), and they are inefficient. There are few incentives for economies as charcoal-making fees are based on the number of bags produced and not on area of wood cut or wood volume. The Government, concerned by illegal forest cutting and the reduction in forest area, has restricted charcoal production in many areas, and commercial wood for urban areas, including wood for charcoal production, now to a large extent comes from plantations.

3.36 Hardly any information is available on quantities or the organization of production, transport and marketing of woodfuels, including charcoal. The production process for charcoal has not been measured for efficiency in Burundi but casual inspection shows that the traditional process, which mounts wood along the flank of the hill slopes, has a low degree of efficiency. Figures between 1 and 1.5 bags of charcoal per stere of wood are commonly quoted which implies an efficiency on a weight bases of 5-15%. Tests carried out in neighboring countries suggest that an efficiency of 10% (on a weight basis) is quite likely. Improved charcoal production methods have been introduced under the First Forestry Project, and savings of 50% or more on wood use are in theory feasible. 10/ Little follow-up on the part of the Government to find ways to transfer improved technologies to charcoal makers, and no proper incentives to adopt the methodologies on the part of the producers due to the low price they pay for wood, account for the lack of progress.

3.37 The First Forestry Project organized early in the 1980s a training and research project to establish more efficient techniques of producing charcoal. In practice, however, the results were not followed up. Currently, three forestry projects (Support to the DF financed by FED, Projet Crête Zaire-Nil financed by the French Cooperation, and the Bank's Second Forestry Project) have activities related to charcoal production. The activities are not coordinated, however, and with maturing plantations all projects need to commercialize wood and anticipate doing this by producing charcoal. The Second Forestry Project has made the most extensive effort to try to identify the most suitable carbonization method and has organized training of charcoalers in different improved techniques. However, these charcoalers have since all left with the result that new charcoalers had to be trained for continued charcoal production. At present, charcoal is being produced using slightly improved techniques at the project's plantations. The two other projects use either traditional or slightly improved traditional techniques.

3.38 It is necessary to revitalize and reorganize the efforts to introduce and disseminate the use of improved charcoal production techniques in Burundi and it is recommended that the necessary activities are organized as a new project with the Direction Générale de Hydraulique et de l'Energie Rurale and the Département des Forêts as counterpart organization. The following main activities are necessary:

(a) limited further testing of improved carbonization techniques/methods;

(b) training of charcoalers;

10/ *As an illustration, if the improved method was generally adopted in Burundi, there would at the present level of consumption of charcoal be savings in the order of 200,000 MT/year of wood, corresponding to 8% of total woodfuel consumption.*

(c) establishing a closer link between charcoaling activities and wood owners so that the issues involved may be addressed jointly;

(d) organizing charcoaling associations which provide, inter alia, access to local sources of financing;

(e) reviewing pricing and price structure of wood and charcoal in order to give proper incentives to use improved techniques; and

(f) organizing of a campaign to make charcoalers and wood owners more aware of the value of wood.

An outline of the project with a budget of US$615,000 for the execution over a three year period is given in Annex 3.8.

Woodfuel Substitution

3.39 In rural areas practically all households use fuelwood for cooking and account for almost 80% of wood consumed by households for fuel purposes in Burundi. There are only very limited substitution possibilities for commercial fuels. This is because, first, the gathering of fuelwood is a subsistence-level non-monetized activity, whereas the sale of commercial fuels requires a degree of monetization. Second, the cost of distributing commercial fuels in rural areas are very high, except in larger villages and rural towns. A comparison of prices/costs of different types of household fuels presented in Table 3.3 below shows wood to be the cheapest alternative by a wide margin in an urban place like Bujumbura, and the difference in favour of wood will be even greater in rural areas. Historically, the consumption of fuelwood has grown in proportion with the growth in rural population and it is difficult to see a substitution towards commercial fuels occurring on any significant scale unless the cost of wood should rise considerably due to physical or economic scarcity. The possibility of this happening in Burundi in the future cannot be ruled out, as discussed in the section on woodfuels balance, but measures to avert such a situation have been proposed in the section on woodfuel supply. Kerosene for lighting purposes is the only alternative modern fuel used in rural areas. The consumption of it is expected to show an increase close to that of the growth of population. Due to the settlement pattern and for reasons of cost, electricity will be limited to urbanized areas.

3.40 Based on the foregoing, the logical policy would seem to be to focus attention as far as substitution efforts are concerned instead on Bujumbura and other towns, where fuel use is most influenced by price and where population expansion is relatively greater. Apart from the share of urban population being low in Burundi (at present around 10% and not expected to increase significantly over the next decade), two factors reduce the significance that can (and probably should) be attributed to substitution in urban areas in Burundi as a significant element in containing the use of wood for fuel (cooking) purposes:

(a) As shown in Table 3.3, there is a marked difference in financial as well as economic terms between the cost of "modern" fuels like kerosene, LPG and electricity, on the one hand, and fuels from biomass like wood, charcoal, briquettes and peat, on the other. The estimated financial cost of the favored fuel for cooking in urban areas, charcoal, 11/ is only 41%, 39%, and 16% of that of kerosene, electricity and LPG, respectively, in terms of useful energy. The costs of these latter fuels therefore effectively rule out their use for cooking purposes for the large majority of households, especially when taking into consideration the cost of appliances which are not incorporated in the figures quoted. Briquettes (from agricultural residues) may be interesting from a cost and user point of view, as explained in Chapter VII, Renewable Energy Technologies, but further studies are needed, and quantities (and therefore the impact on woodfuel consumption) are likely to be very limited. Peat, as discussed in Chapter VI, has a greater potential as a fuel for institutions and for industrial purposes than for households, among which acceptance has so far proven to be low due to difficulties in peat combustion and the high ash content, thus reducing convenience in use compared to charcoal. The conclusion seems inescapable that also urban areas will remain highly dependent on woodfuels for the foreseeable future; and

(b) As discussed earlier, the supply of wood for urban areas should be well taken care of from private and public plantations, a situation that is expected to last beyond year 2000 based on the capacity of existing plantations. Thus the need to encourage substitution away from woodfuels among urban households seems less urgent or even not desirable, given the foreign exchange costs associated with the use of modern fuels. As mentioned earlier, the price of charcoal has remained constant for several years now, and the combination of expected adequate supply of raw material (wood) and proposed renewed efforts to disseminate more efficient charcoal production techniques and improved charcoal stoves should contribute to maintaining a relatively stable price of charcoal. Barring major reductions in oil prices or significant increases in distances for the transportation of charcoal to urban areas, the price gap in favour of charcoal would seem to rule out major switches from charcoal to modern fuels, except at a gradual pace reflecting increased level of income and the convenience associated with use of the latter type of fuels, as perceived by the households.

3.41 The conclusion therefore is as follows: Efforts at substitution away from the use of woodfuels by households are not a priority option at present in Burundi. As far as rural households are concerned, for resource and environmental reasons it would be desirable to promote a switch, but this does not appear feasible in the foreseeable future. With respect to urban households, substitution on a scale that has a real impact on the stock of resources is not likely nor desirable (based on the present sources of supply). This does not mean that efforts to develop alternative household fuels and their use should be discontinued, as discussed in later chapters. The implication is, however, that the Government

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11/ *Surveys in Bujumbura have shown that 85% of the households use charcoal as their main cooking fuel, the remainder using mostly purchased wood. The amount spent on the purchase of charcoal is the equivalent of 10-15% of the amount spent on food.*

should limit the resources it puts into such activities, leaving more to the private sector to pursue possibilities that are economically and financially viable, and rather concentrate on:

(a) increasing wood supply in rural areas, mainly through agroforestry (paras. 3.26);

(b) promoting increased efficiency in the production and use of woodfuels (paras. 3.38 and 3.34); and

(c) seeing to it that fuel prices - where administered - are set so as to promote economic efficiency as well as financial and social objectives (see next section).

Table 3.3: PRICES AND COSTS OF HOUSEHOLD FUELS IN BUJUMBURA, 1989

Fuel	Type of price/ cost a/	Unit	Calorific value (MJ/unit)	Price BUF/unit	Price BUF/MJ	Efficiency of combustion %	BUF/MJ eff.
Fuelwood	M	kg	16	2.1 b/	0.13	15	0.9
Fuelwood	E	kg	16	3.4 c/	0.21	15	1.4
Charcoal	M	kg	32	17	0.55	25	2.2
Charcoal	E	kg	32	27 d/	0.84	25	3.4
Briquettes	M	kg	[illegible]	28	0.93	25	3.7
Peat	M	kg	14	8	0.57 g/	-	-
Kerosene	A	liter	35	85	2.4	45	5.4
Kerosene	E	liter	35	88 e/	2.5	45	5.6
LPG	A	kg	42.5	300	6.7	50	13.4
Electricity	A (LV)	kWh	3.6	16	4.4	80	5.6
Electricity	E (LV)	kWh	3.6	22.5 f/	6.3	80	7.8

Note: All economic figures are tentative calculations.

a/ Prices/costs: M = market (financial) price; E = economic cost/LRMC; A = administered price.
b/ Fuelwood around Bujumbura sells for BUF 1,000/stere (corresponding to BUF 2.10/kg). In comparison, the current stumpage fee of BUF 415/stere.
c/ The price is very tentative and based on an approximation of LRMC of BUF 845/stere calculated in Annex 3.9, to which transportation costs of BUF 35/MT/km in economic terms for a distance of 35 km, i.e. BUF 600, and a distribution margin of 15%, are added, in total BUF 1,650/stère.
d/ From Annex 3.11.
e/ Official retail price minus import duties and taxes for product transiting via Kenya, adjusted for a 20% overvaluation of BUF.
f/ See Chapter V.
g/ Peat is not a household fuel in Burundi at present.

Source: DGE, mission estimates.

Costs and Pricing

3.42 The Government has not yet defined a coherent policy on pricing although the framework was adopted when it approved a Forestry Policy document in 1985, where it stated its commitment to encouraging recovery of costs from beneficiaries and to rendering services and institutions self-supporting. Under the Second Forestry Project this was made more explicit and it was agreed, inter alia, that

(a) stumpage and permit fees were to be set allowing the DF to cover its operational costs as well as to maintain afforestation levels;

(b) the price of seedlings would be raised to varying levels for different users (for certain categories up to full cost) and the rates would be standardized;

(c) support would be provided to the Government both for the analytic and implementation work needed to establish an improved pricing system, under which the more precise formula for determining pricing levels would also take into account, inter alia, the cost of alternative sources of energy and the existence of "free" wood from various sources;

(d) the timetable for a gradual implementation would be such that full cost recovery would actually be in force by the end of the project period, originally foreseen for 1990.

3.43 These agreements and intentions have not been followed up. The question of pricing of wood is complex, as shows experience from other countries. For trees on "private land', including all trees planted by farmers, no tax or payment is involved, and by tradition farmers gather and cut wood wherever it is available. In principle, utilization of areas of natural forest, of Government plantations and of communal plantations is strictly regulated, and either a permit fee or a communal tax is payable. In practice, it is difficult, if not impossible, for the Government to control cutting of trees and collect fees except on large plantation blocks. The Government hesitates to increase rates in the fear that it would increase illegal cutting and marketing of forest products. The staff of the DF is limited and plantations are widely scattered, and no effective monitoring system exists making it difficult to control or to keep track of what is actually happening in the subsector. In this respect, not much has happened since the Second Forestry Project was agreed on. For a number of reasons, however, the need for devising an effective and enforceable system is more urgent than ever, including the fact that a number of plantations, as mentioned before, have now reached or are in the process of reaching maturity.

3.44 Fuelwood prices are free market prices, but the Government intervenes by setting a stumpage fee of BUF 415 per stere of standing wood (in effect from 1987) from public plantations and other Government or communal land. Furthermore, a transport tax of BUF per bag and a community tax corresponding to BUF 50 kg bag of charcoal is levied when charcoal (and correspondingly for other commodities) cross the border between two "prefectures".

3.45 One of the few documented wood cost calculations made refer to the Mageyo eucalyptus plantation. 12/ Table 1 in Annex 3.9 shows the establishment costs of the plantation (US$640/ha) 13/ and in Table 2 a calculation has been made that gives an indicative LRMC for wood

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12/ *Established by the Second Forestry Project, at present maintained by the French Cooperation under the Crête Zaire-Nil Project.*

13/ *The Second Forestry Project reports establishment costs in the same order of magnitude: US$625/ha for eucalyptus and US$480/ha for pines.*

from this plantation. A number of conditions are site-specific and the figure of BUF 845/stere (US$5.30, or US$7/m3) is not necessarily representative of public plantations in general. Private plantations are reported to be operating at lower cost but also to have lower yields. 14/

3.46 The perception of non-commercial wood in most cases being "free", the fact that 75-80% of the fuelwood consumed in the country does not enter commercial circuits, combined with a possible underpricing of wood from private plantations, substantially limits the possibility of influencing wood prices and of raising stumpage fees to reflect more closely the real cost of wood, and creates problems with respect to being able to successfully enforce actual collection of such fees. Any increase in wood prices increases the inducement to illegal cutting. All these factors have to be taken into account when drawing up a new framework for the pricing of woodfuels.

3.47 Two price/cost comparisons are relevant: as indicated above, the LRMC of wood as represented by the Mageyo plantation, BUF 845/stère, is more than twice the official stumpage fee. Adding transportation costs to Bujumbura and a reasonable distribution margin (15%) to the LRMC at Mageyo, a total of approximately BUF 1650/stère, gives a cost that may be compared to the market price of fuelwood around Bujumbura of around BUF 1000/stère (see also Table 3.3). Both comparisons show that present official as well as market prices for fuelwood are well below the real cost of wood (from public plantations). Apart from inducing overconsumption, the low prices give no incentive to grow trees for firewood alone. 15/

3.48 Charcoal, which represents the major use of commercialized wood, costs BUF 750 per bag of 45 kg in Bujumbura. The price roadside the location of production varies from place to place but can be taken to lie around BUF 350. The difference is partly transport and taxes but primarily distribution margins and profit, as shown in Annex 3.11. The implicit or residual value of the wood used in the production of the charcoal, after deducting the payment to charcoalers hired by private plantation owners, is BUF 190 (per bag and per stère). This amount corresponds roughly to the lump sum price of BUF 27,000/ha paid by charcoalers for the right to cut trees on Government owned land, a fee that has remained unchanged for a number of years. There is no control with the quantity of wood actually taken from a hectare of land and it is likely that the value of the wood actually cut exceeds what was supposed to be reflected by the lump sum. As an illustration, one hectare of industrial plantation represents a wood value of at least BUF 100,000 (valued at the official stumpage fee). The figures above

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14/ *The assumed lower costs of private plantations may not necessarily reflect reality, however, since there appears to be an undervaluation on the part of the farmer or private plantation owner of the real cost of establishing (which may be the result of the initiative and labor of a previous generation) and maintaining a farm forest or plantation. It should also be taken into account that the farmers purchase seedlings at subsidized prices. Wood from private plantations may therefore in many cases be underpriced and a certain erosion of the value of the standing stock of trees is therefore quite possibly taking place. As no cost or yield data from private plantations are available, these assumptions based on spot observations and ad hoc evidence would need to be verified.*

15/ *Uses of wood for other than for woodfuel obtain higher market prices, as shown in Annex 3.10, but quantities are small.*

show that the implicit value of wood in charcoal is not only considerably below the LRMC of wood but approximately 50% of the official stumpage fee of BUF 415/stère. Using the LRMC of wood of BUF 845/stère to which the other cost elements (in economic terms) are added, gives an economic cost of charcoal of roughly BUF 1200/bag, as compared to the present price of BUF 750.

3.49 The lower market prices of firewood and charcoal leads to higher consumption than what is desirable from society's point of view, they do not give proper incentives to develop and adopt efficient methods of charcoal production nor to use improved stoves and, finally, they mean that the rural wood producing population is subsidizing urban households. It is therefore recommended that

(a) the cost of commercialized wood from public and private sources and the taxation of charcoal be studied as a basis for deciding on a pricing policy for wood from public plantations; 16/

(b) means of significantly improving the low degree of collection of fees be identified and implemented; and

(c) an awareness campaign as to the value of wood be initiated, focussing on the population in general as well as on the tree growing and wood producing farmers and plantation owners in particular. (Such a campaign should form an integrated part of the program mentioned earlier aiming at the dissemination of improved stoves and be implemented prior to any price changes.)

3.50 The timing of a review of woodfuel prices now is particularly relevant for several reasons. As mentioned, several industrial plantations are reaching maturity. The question of pricing becomes important not only for these quantities over the longer term but also as for the short terms issues associated with the potential surplus of wood when these quantities are added to those of private plantations. It is essential to avoid a situation where private plantation owners are forced out of business due to ill-conceived pricing and marketing measures related to publicly financed projects. In addition, with the maturing of the plantations, more accurate and up-to-date information and data on yields and costs will become available, as a basis for reassessing stumpage fees and taxes. Finally, since unallocated funds are still available under the Second Forestry Project, it is recommended that the project finances the pricing study, as originally intended.

3.51 Allowing the DF to benefit from the increased public revenues will improve the chances of successful implementation of the measures and give the organization a financial basis that should better enable it to carry out its functions as outlined in the next section.

16/ *In neighboring Rwanda, a system of dual charcoal tax collected by the municipalities at certain roadpoints has been proposed, aiming directly at encouraging the adoption of more efficient charcoal production methods. The tax on charcoal originating in areas where improved charcoal production techniques have been adopted is considerably lower than for charcoal produced in areas where the traditional method is still in use. The possibility of introducing such a system in Burundi is less, due to the administrative structure there but other forms with the same objective should be explored.*

3.52 The comparison of financial prices vs. economic costs of different household fuels presented in Table 3.3 earlier in this chapter, shows that the discrepancies between the two sets of prices are relatively greater for woodfuels than for modern fuels (electricity and kerosene). 17/ A rise in the price of woodfuels up to the level of their economic costs should, based on the preliminary and indicative figures, not alter their pricing advantage as cooking fuels, however, which is considerable especially when taking the cost of appliances into consideration. As mentioned earlier, only a gradual substitution towards modern fuels is expected or even desirable, and more correct prices of all household fuels should only have a modest impact on this process.

Institutional Aspects

3.53 The central institution on the supply side of the major household fuel, wood, is the Département des Forêts in the Ministère de l'Aménagement, du Tourisme et de l'Environnement. The responsibilities of the DF include, inter alia: implementation of the Government's forest policies, management of reserved natural forests, and management of man-made plantations. The Department is a small organization with 86 professional staff, mainly agricultural engineers, recruited from the University of Bujumbura. It is supported by four externally financed forestry projects with initially substantial technical assistance components: The World Bank Second Forestry Project; FED Forestry Support; Belgium/Saudi Arabia Pilot Reforestation Project; and FAC Reforestation Crête Zaire-Nil. Coordination between the projects is weak, however, they operate independently and no coordinating strategy exists for the marketing and use of the wood from these now maturing plantations. The FD has representatives at each province headquarters and in many of the prefectures but both the number of staff and the equipment is insufficient to carry out their functions properly.

3.54 The number one problem of the Département des Forêts is the lack of qualified staff with proper forestry background. Secondly, the Department needs to adapt its organization to the major challenges it faces. In general, but also as a consequence of the recommendations made earlier in this chapter, the DF needs to strengthen its capacity to address issues within its area of responsibility, including (a) determining and monitoring the country's forest resource base (including plantations), (b) preparation of policies on exploitation and maintenance of resources, (c) protection of natural forests, (d) preparation and implementation of agro-forestry projects (including extension services and project monitoring), (e) monitoring the program aimed at disseminating improved carbonization techniques, and (f) reviewing woodfuel pricing and taxation and enforcing collection of fees and taxes.

3.55 Strengthening the DF will have to be addressed through a combination of an increase in the number of local staff, improvement of their skills through training, and continued external support in the form of technical assistance. Regional forestry offices are in particular need of reinforcement. Furthermore, additional means of transportation are badly required. Most equipment is old, inadequate and poorly maintained because of because of lack of funds. It is therefore recommended that a review be carried out of the organization, staffing and resource requirements on the basis of the major challenges that the DF will be facing in the years ahead and taking into account the role that the private sector can

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17/ *Pricing of modern fuels is discussed in the respective chapters.*

play (e.g. with respect to industrial plantations). It would seem logical that the preparation and implementation of the indicated institutional improvements be organized and funded under the Second Forestry Project.

3.56 As mentioned in the chapter on energy institutions, various aspects related to household energy are under different institutions: Demonstration of efficiency in charcoaling operations is under the DF, promotion of efficiency in end use of wood and other biomass under the DGHER (Direction Générale de l'Hydraulique et de l'Energie Rurale) but also under ONATOUR. The DGHER, under the MDR, as well as CEBEA (Centre d'Etudes Burundais des Energies Alternatives) and the DRS (Département des Recherches et Statistiques), both under the DGE, are all involved in various but partly overlapping aspects of alternative household energy technologies and projects. The DRS also carries out household energy surveys. A certain restructuring of the responsibilities for alternative technologies are underway, as indicated earlier, but there is still a clear need to coordinate better the activities related to household energy, in general, and to integrate household energy planning (including wildfowls) in one unit, although the actual implementation should remain the responsibility of different organizations, as is the case at present, preferably within the Département de la planification or the Département de la Promotion et des Etudes.

3.57 It is therefore recommended that a household energy unit be given the task of planning and coordinating such activities. The main purpose of such a unit would be to monitor the situation in the household energy field, make policy proposals and initiate/supervise projects. It would more specifically have the following responsibilities:

(a) the monitoring of the supply/demand situation of wildfowls, in cooperation with the DF;

(b) the monitoring of projects dealing, in one way or another, with household energy, as well as monitoring of technical, economic, and financial data on available solutions for reducing (or substituting) wildfowls demand;

(c) the identification of programs to reduce the main imbalances in the supply/demand pattern for household fuels;

(d) the design and implementation of guidelines related to the private and public sectors as well as to NGOs in order to clarify areas of responsibility with the objective of improving management and promoting development of household energy technologies; and

(e) maintaining information flows with executing agencies and the DGE in order to produce periodical reports to be used in the preparation of the National Plan.

3.58 Household energy planning units have been or are being established in several developing countries, usually as part of broader efforts to implement energy policies. In all of these cases, household energy planning units have meant better coordination and improvement of information planning systems and proved to be very valuable for energy planning. The location of such a unit as well as the need for

technical assistance in the initial stages should be given consideration by the Government. However, there is little doubt that the DGE offers several comparative advantages for hosting this unit, with its overall responsibility for energy management in the country. To avoid creating a new department, it is recommended that the present DRS within the DGE have its scope expanded to cover said functions and be strengthened accordingly. As mentioned above, the DRS is already involved in renewable energy technologies and household energy surveys. The ongoing German funded PSE (Programme Spécial d'Energie) attached in an advisory role to the DGE on energy planning and renewable technologies would seem well suited to assist in the detailing and implementation of the household energy unit.

Recommendations

3.59 The following summarizes the mission's main recommendations:

(a) With very limited substitution possibilities, continued heavy reliance on woodfuels on the part of households for their energy needs, and a situation where wood resources are being depleted, fuelwood and charcoal should be the main targets for measures aiming at improving the household energy supply/demand situation, by increasing supply and by improving efficiency in production and use of these fuels. However, the existing data are inadequate on the demand side as well as with respect to wood resources to permit the formulation of more detailed policies and plans within the subsector. It is therefore recommended the following suveys be carried out: (i) a national inventory of wood resources and production (including natural forests/woodlands and man-made plantations); and (ii) a national household energy demand survey. The DF and the DRS will require technical and financial assistance in carrying out these surveys and the Government is in the process of preparing requests for such assistance. For the wood resource inventory, financing could be sought from remaining funds from the Second Forestry Project;

(b) To ensure and improve the supply of woodfuels in rural areas and to counter negative environmental impacts of wood cutting for agricultural and fuel purposes, increased emphasis should be put on agro-forestry projects, including nursery programs and extension services. The design of the programs should take into account the need to elicit the participation of the population in the planting of trees around the homesteads and in the farmers' fields, by including the necessary incentives and support to the farmers. The establishment of new wood plantations should be limited to highly specific cases. The assistance needed by the DF to carry out such a program would be closely linked to a reorientation and strengthening of the DF and its regional offices (see recommendation (f));

(c) A strategy should be designed for the management of wood resources on a national level, including plans for the exploitation and maintenance of industrial wood plantations and for the use and commercialization of wood from these plantations, taking due account of supply from existing private plantations in relation to major consumption centers of commercial woodfuels. A role for the private sector in the operational phase of public

plantations should be considered. It is proposed that these issues be studied and implemented as part of the finalization of the projects responsible for developing the industrial plantations referred to above;

(d) To reduce woodfuels demand through energy conservation it is recommended that the improved charcoal stoves and carbonization programs be reoriented along the lines indicated in the text and that the management of the programs be entrusted to the organizations with the necessary capacity to ensure proper implementation and follow-up. (in the case of the improved carbonization program these are the DF and the DGHER). The private sector should be called upon to play a major role in the commercial phase of the stoves program. In order to facilitate the adoption of more efficient carbonization techniques, the pricing and taxation of wood and charcoal need to be reconsidered (see (e)). Technical assistance to the respective organizations will be required;

(e) Based on estimates of the real costs of woodfuels and on the prices of alternative household fuels, it is recommended that the pricing and taxation of commercialized wood and charcoal be reviewed and measures to more effectively enforce collection of fees and taxes be implemented. Prior to the price and tax revision, an awareness campaign as to the value of wood should be initiated. Support to the DF should be provided for the analytic and implementation work needed to establish the improved pricing system, and a realistic timetable for the gradual implementation should be established. Funding should be sought from the Second Forestry Project;

(f) On the basis of the major tasks and challenges in the years ahead in the forestry subsector (those most directly related to woodfuels having been indicated in the text), it is recommended that the specific role and responsibilities of the Département des Forêts be redefined and that on this basis the organization, staffing and resource requirements including the need for technical assistance of the DF be considered. Funding for these activities could be provided by the Second Forestry Project; and

(g) The Département des Recherches et Statistiques should have its scope expanded and it should be given the responsibility for monitoring the situation in the household energy field, making policy proposals, initiating/supervising projects, and coordinating donor activities in this area. This would imply a clear need for strengthening and training of the staff in the DRS in data collection methods and surveys, economic analysis, and in energy planning issues. Assistance from PSE should be sought.

IV. PETROLEUM PRODUCTS

Background

4.1 Petroleum products account for about 85% of commercial energy consumed in Burundi. They are entirely imported, representing close to 15% of the country's total merchandise imports and 20-30% of merchandise exports. 18/ Per capita consumption of petroleum products, however, is only 10 kgoe which ranks among the lowest in Africa. This is due not only to the modest size of the industrial sector but also to the low petroleum energy intensity of the productive sectors and to the relatively high cost of petroleum products. The supply of oil products to Burundi is affected by two main constraints: its geographic location and the small size of the market.

4.2 The natural ocean ports of entry to the country are Dar es Salaam and Mombasa and the main supply route entails crossing three national borders. The transit route from Mombasa is 2,190 km long, crossing Kenya, Uganda and Rwanda, and the route by truck from Dar es Salaam is 1,580 km, crossing Tanzania and sometimes also into Rwanda. The long distances from the ports of entry on the coast and the partly very poor state of the roads and the railroad network have two consequences specific to landlocked countries like Burundi: transport becomes a high cost component in the final price of petroleum products and the reliability of supply is affected. In addition, the small size of the national market which is split between 6 distributing companies reduces order quantities and precludes access to the international market and more competitive prices there.

Structure and Evolution of Demand

4.3 Like most less industrialized countries, Burundi consumes much more white products (gasoline, diesel, jet fuel and kerosene) than heavy fuel oil. In 1988 automobile fuels -gasoline and diesel - accounted for almost three-fourths of total consumption of oil products, and heavy fuel oil (used mainly in a few industrial enterprises) for 14% (see Table 4.1). The use of kerosene, primarily for lighting, is very low and has barely increased during the 1980s.

Table 4.1: PETROLEUM PRODUCTS MIX, 1988

Product	MT	Share %)
Premium gasoline	19,366	36.6
Diesel	19,332	36.7
Fuel oil	7,592	14.3
Jet fuel	4,780	9.0
Kerosene	1,604	3.0
LPG	150	0.3
Avgas	46	0.1
Total	52,870	100.0

Source: Société d'Entreposage de Pétrole (SEP).

18/ *These figures are representative for the situation prior to the international price increases in 1990.*

4.4 Consumption of petroleum products grew by an average of 5% per annum during the period 1981 to 1988, from some 38,000 MT to close to 53,000 MT, reflecting the relatively modest growth of the economy. The increase in petroleum products consumption has been highly uneven with quite wide variations and even decreases in some years, as shown in Annex 4.1. There is no obvious justification for these variations which, at least partly, probably can be explained by illegal exports to the neighboring countries, Zaire and Rwanda, during periods of shortages there and with higher prices in those markets. The only product that has shown a reasonably steady growth is fuel oil which is not exported illegally.

4.5 Based on information from the largest supplier, it can be estimated that

(a) 75-85% of gasoline is sold through service stations, 10% is delivered to large consumers (industries and truck fleets) and 5-10% goes to the Government;

(b) kerosene is largely sold through the retail network; and

(c) diesel for automotive use represents 60-65% of consumption and 35-40% is delivered directly to large consumers (industries and power plants).

4.6 The fairly moderate growth in petroleum products consumption in the past is expected to continue, on the background of an economy surrounded by many uncertainties and dependent on a few main export goods that are vulnerable to developments in the international market, plus an expectation of no substantial additions to industrial capacity. The development of the demand for oil products will therefore be the combined result of a moderate growth in economic activity and developments in production methods and life style. Aggregate consumption is expected to increase to some 92,000 MT by year 2000, 19/ or at an average rate of 4.7% p.a. Details on the forecast of individual products and the associated assumptions are found in Annex 4.2.

Organization of the Petroleum Sector

4.7 Petroleum products are currently imported and distributed in Burundi by five companies, with market shares in 1989 (first 8 months) as indicated below (source: Fina/BP):

	Market Share %
Fina/BP	35
Hydrobur	25
Sicopp	17
Petrobu	16
Ercoil	3
Cobuco	4

19/ *This quantity still corresponds only to around 80% of the present per capita consumption of petroleum products in neighboring Rwanda.*

Cobuco which had a market share of 12% in 1988 reduced its activities in the course of 1989 and Ercoil started its operations the same year.

4.8 Fina/BP, the joint venture of the two multinationals, had a market share of 80% in 1983 which caused concern in the Government. The company has since adopted a lower profile and is prepared to comply with the Decree-Law that requires the sale of 51% of its shares to Burundian nationals. Fina/BP will, nevertheless, keep the management of company, something which is considered of prime importance for efficient storage and distribution of petroleum products in Burundi.

4.9 The other companies, Hydrobur, Sicopp and Petrobu are Burundian companies that are the successors of Shell, Texaco and Mobil, respectively, from which they acquired the distributing facilities and the retail network. The Burundian companies have also kept some upstream connections with the multinationals and this has enabled them to survive in a market with some supply difficulties. The Government has a 20% participation in Sicopp Ercoil is a newcomer and despite its lack of assets was able to capture almost 3% of the market through sales to large consumers like state companies, the army and some industries that split their requirements among all the petroleum companies.

4.10 The quantities sold by the five companies operating in Burundi in 1988 are shown in Annex 4.3 and illustrates the modest quantities taken annually by the companies (ranging from 22,000 m3 for Fina/BP to 8,000 m3 for Cobuco), thus preventing them from direct access to the international market. The companies are in principle free to negotiate the purchase of their requirements with the suppliers of their choice. In reality, they face the following constraints:

(a) In the official price structure, the point of departure is the price FOB Mombasa, FOB Kigoma, FOT Nairobi and FOT Dar es Salaam, according to the source and surface route used. The importers are limited financially by that price since if the actual price from the supplier is higher, this cuts into their wholesale margin; and

(b) An import permit for allocation of foreign currency is required and the Banque de la Republique Burundaise (BRB) may refuse the amount requested if it does not match the FOB/FOT price in the official price structure even if the importer is prepared to sacrifice some of the wholesale margin.

4.11 In addition, the selection of the transporter has so far represented a further constraint since the BRB usually refuses the allocation of hard currency for payment of foreign transporters even when the freight rate is lower than the one retained in the price structure. This price protection to local, often more expensive, transporters will gradually be eliminated since the Government recently agreed, as part of negotiations with the Bank on the country's transport sector policy, that the choice of transport operators will be left to the importers, without interference by the BRB.

4.12 Petroleum products are viewed in Burundi as commodities and not as a source of energy and this is reflected by the fact that their import, storage and distribution is under the authority of the Ministere du Commerce, de l'Industrie et de l'Artisanat (MCIA), without involvement by the MEM

except for the preparation of some statistics. The latter is responsible, however, for petroleum exploration, through its Direction Generale de la Geologie et des Mines. The Government reserves to itself a role of supervision and control of the subsector, using levers such as price control, regulation of transportation (to be abolished), and investments in storage facilities. The participation in Sicopp appears not to have been used for intervening or gaining particular insights into the oil market mechanisms or cost structure. The Direction Generale du Commerce carries out the supervising activities but with very limited capacity and expertise in international supply and trade of petroleum products, and therefore with few means of following up on issues that are of importance to the country. There is limited communication with other ministries, such as Transport, Finance and Planning, which have matters related to petroleum products under their jurisdiction, and the relationship with the petroleum operators have been quite strained at times. Important subsector decisions have been taken in the past with little or no involvement of the latter.

Petroleum Storage

4.13 All petroleum products are brought to the storage facilities of Societe d'Entreposage de Petrole (SEP) near the port of Bujumbura. SEP is a company owned by Fina/BP, Shell, Petrobu and Sicopp. In the first years, SEP was operated as a non-profit making entity for the exclusive use of the shareholders. Now, all the distributing companies use the facilities and pay a throughput fee of BUF 1.50/liter (which is slightly above the fee used in the official price structure). These translate into fees of US$12/MT for gasoline and US$11/MT for diesel which are high compared to those charged by depots in some other African countries: V.R.D.I., Abidjan: US$5/MT; SAR, Dakar: US$6.45; MOBIL, Bamako: US$5.80; MEPP, Nouakchott: US$9.25. Not surprisingly, SEP's operations have been profitable. The financial situation has enabled SEP to undertake improvements of the depot and for African countries SEP's depot is unusually well kept and maintained.

4.14 The total storage capacity of the depot is 12,000 m3, consisting of 6 tanks of a total of 2,800 m3 for jet fuel/kerosene, 5 tanks of 4,250 m3 for gasoline, 3 tanks of 2,800 m3 for diesel, one tank of 1,350 m3 for fuel oil, and 2 service tanks with a total capacity of 800 m3. The SEP storage is a customs bonded warehouse which means that custom duties are paid only when the petroleum products leave the depot, not when entering the country.

4.15 For various reasons (political unrest in some of the neighboring countries, occasional shortages of foreign exchange on the part of the Kenyan Government to purchase crude oil, bad road conditions) Burundi has experienced disruptions in the supply of petroleum products and therefore shortages in the past. This led the Government to build a depot in the second largest town, Gitega, in 1983/84, with the cooperation of and financing from the French Government, for strategic reserves. The decision itself as well as the size and design of the depot were questionable: four tanks totalling 20,000 m3 which have not been in use since commissioning. Financing for the stocks were not secured and no company has been willing to take on the operation of the depot until the Government signed a contract in 1989 with a company called Al Hamad International, based in Sharjah (U.A.E.). The idea behind the contract was that Al Hamad would use it as a customs bonded transit depot for storage of products destined for the neighboring countries and for Burundi itself.

4.16 The project might have had a certain merit if Al Hamad had been a state oil company of a Middle East producing country with an excess of refined products. This has been done by Nigerian and Kuwaitan companies in other countries and although these and other companies are looking for downstream outlets it is doubtful whether they would be interested in a landlocked location as Gitega. Al Hamad, on the other hand, is not a state oil company, does not have a standing in the international market and does not have access to petroleum products on advantageous terms, nor have negotiating power vis-a-vis the multinationals that control the facilities at the sea ports. To unload, store and load onto car/rail it would have to use the terminals at Dar es Salaam or in Mombasa controlled by these companies, which means Al Hamad would be in the same situation as the companies currently operating in Burundi.

4.17 The above mentioned situation, uncertainties regarding some of the terms in the agreement with Al Hamad, and the fact that little has happened since the signing of the contract indicates quite strongly that Burundi does not have much to expect or gain by insisting on implementing the agreement. In fact, Burundi's needs for security stocks, as discussed later in this chapter, are at present not larger than can be taken care of by the SEP depot in Bujumbura. Consideration should be given to letting SEP operate the Gitega depot as an extension of the Bujumbura depot from the point in time required. As for Rwanda's needs, additional storage facilities sufficient for a number of years ahead were completed in 1988, for which the country is looking for financing.

Sources of Supply

4.18 Burundi has five possible sources of supply:

(a) The purchase of refined products from the refineries in Mombasa and Dar es Salaam;

(b) The purchase of refined products in the international market, which in the case of Burundi would mean from refineries in the Middle East or along the Mediterranean Coast, and shipped to the depot of Esso or BP in Dar es Salaam or to the storage facilities of Shell/BP in Mombasa;

(c) The purchase from the multinationals that own and operate depots in Mombasa/Nairobi or in Dar es Salaam. This alternative is in the end a variant of alternative (b);

(d) The purchase of crude oil from a producing country in the Middle East and refining it in one of the refineries in the neighboring countries under a processing agreement; and

(e) A potential alternative would be supply through coordinated purchases for this and other sub-regions of Africa, as considered in a study under preparation by the Bank.

Other supply options exist but these are occasional sources for emergency situations or are alternatives for certain products and not economic options for larger quantities on a continual basis.

4.19 The first alternative should, in principle at least, represent the least cost source of supply since the two refineries should be able to process crude oil and sell the products at a cost of parity with the international market. That is, however, not the case. The Dar es Salaam refinery does not have a capacity to serve the entire domestic Tanzanian market and, consequently, does not have surpluses for export. Tanzania is, in fact, a net importer of white products. The Mombasa refinery was built for export of products to neighboring countries; its 74,000 barrels/day throughput capacity exceeds the demand in Kenya. It charges, however, export prices that are above the parity price. 20/

4.20 The second alternative, purchases in the international market, would be an interesting option from a price point of view. There is an abundant supply of finished products in the Middle East at competitive prices, but several constraints apply. First, small operators like the importers in Burundi cannot purchase petroleum products in the international market, the Middle East or from Mediterranean refineries on a regular basis. That would imply importing in lots of 10-15,000 MT which represent for them one year's sales. Fina/BP is the only one that could do it by pooling its imports with the requirements of BP in Tanzania. It is easier, however, for Fina/BP to buy from BP's stocks. Secondly, the maritime transport would represent a barrier. Due to the small requirements of the individual Burundian operator and to minimize freight costs, the importer would have to seek the cooperation of one of the large petroleum companies operating in the Indian Ocean who control the small clean tankers capable of delivering quantities of 3-4,000 MT. This type of cooperation is unlikely to be obtained for competitive reasons. Thirdly, the products would have to be discharged at the reception and storage facilities in Mombasa or Dar es Salaam. The depots are controlled by the multinationals who have no incentives to accommodate small Burundian operators. This might possibly pose less of a problem in Dar es Salaam than in Mombasa since in the former port there are reception facilities independent of the refinery. In Mombasa, on the other hand, these facilities belong to the companies that have interests in the refinery there and in the pipeline Mombasa - Nairobi. The pipeline is mandatory for transit of white products. Finally, there is the question of depot throughput fees paid in Kenya or in Tanzania. These are with the present arrangement (see below) high but acceptable. Should the products be purchased from international traders and not from the refinery operators it is unlikely that the fees would remain the same as at present.

4.21 The third alternative is the one that is actually in use. Fina/BP in Burundi covers its requirements from the supply system of the parent companies. BP is particularly strong in the area owning and operating an oceanic terminal in Dar es Salaam and being a shareholder in the Mombasa refinery and in the pipeline to Nairobi. BP imports products from Bahrein, Kuwait and Europe, or purchases products processed in Mombasa. The other operators purchase products from the major companies that they represent: Mobil, Shell and Texaco, all of them operating on the east coast of Africa. Another potential supplier for them is Total which operates an important storage terminal in Djibouti. The third alternative could have been acceptable if the purchase price were close to the price

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20/ *The parity price is a price equivalent to the cost of the product in the international market (in this case the refinery centres in the Middle East) plus freight from the Persian Gulf to Mombasa and a throughput fee for reception and handling of the products at the ocean terminal.*

in the international market. The selling companies, however, align their prices with those of the Mombasa refinery posted prices which are normally US$20-30 higher than the parity price.

4.22 The fourth alternative does not make sense from an economic point of view. Burundi's demand is tilted towards white products (around 85%). To cover the 45,000 MT annual consumption of these products, Burundi would have to process approximately 95,000 MT of crude oil which would also yield around 46,000 MT of fuel oil. Burundi's present requirements are only 8,000 MT and the remaining 38,000 MT of fuel oil would have to be re-exported at a considerable penalty as there is a surplus in the region. In addition, the only refinery with spare capacity to process third party crude is the Mombasa refinery which has high processing charges. The whole operation would be very uneconomical compared to purchasing products even at Mombasa and Dar es Salaam posted prices. The alternative is, nevertheless, an option should the current situation of the refining industry or the price of crude oil versus finished products change.

4.23 The fifth alternative is under study and may be an option for the future. A decision to go ahead with a regional solution for supply including Burundi would be followed by a design phase for port facilities, transportation improvements, etc., which might be completed in a couple of years time, and an implementation phase. If implemented, this would be a medium to long term solution.

Supply Routes

4.24 There are two surface routes over which large quantities of petroleum products may be imported Burundi (see map in the back of the report):

(a) The "northern corridor" is the route Mombasa - Nairobi by pipeline in the case of white products or by truck for fuel oil, and Nairobi - Bujumbura through Uganda and Rwanda by truck, totalling a distance of 2,190 km. Total transport cost for gasoline is US$262/MT, of which US$52 is for pipe-line transit and US$210 for the truck transport. For fuel oil the truck cost Mombasa - Bujumbura is US$188/MT;

(b) The "central corridor" has two alternatives:

(i) Dar es Salaam - Kigoma by railroad (1253 km) and Kigoma - Bujumbura by barge on Lake Tanganyika (175 km). Total cost including throughput fees in Dar-es-Salaam and Kigoma is US$107/MT. The use of this route is limited by the lack of railroad capacity and low reliability; and

(ii) Dar es Salaam - Manyoni - Singida - Isaka - Bujumbura is 1,580 km by truck, crossing Tanzania and, depending on season, into Rwanda. Total cost is US$254/MT, including throughput fee in Dar es Salaam. 21/

21/ *A future alternative is a road/rail variation, by railroad from Dar es Salaam to Isaka, where a new terminal for Rwanda has been financed by EEC, and road transport from Isaka to Burundi.*

4.25 A comparison of the costs of the two truck route alternatives, (a) and (b)(ii) (since (b)(i) is severely limited by the rail capacity in Tanzania), shows little difference between the two "corridors" in financial terms. In economic terms, however, it is likely that the cost difference is greater, in favor of the central corridor. The question of greater transparency with respect to cost components in the build-up of petroleum prices, as a basis for price reductions once the bottlenecks in the transportation system are reduced, is studied as part of a Bank-financed study: Tanzania Petroleum Sector Rehabilitation Project. The central corridor truck option is an alternative to the northern corridor in a very limited sense, since some stretches of the road are not realistically accessible during the rainy season, forcing the trucks to use emergency routes which are longer. The majority of Burundian transporters refuse to go to Dar es Salaam for this reason and due to the need for more powerful trucks along this route. In addition, the present price structure combined with a regulated market for transport services has not given the importers proper incentives to use the central corridor, a situation which is contrary to national interests. The process of deregulating international transportation and the paving of additional parts of the road through Tanzania under a FED-financed project, should make the truck option of the central corridor more competitive with the northern corridor. This could result in quite significant savings on transport costs in view of the shorter distance along the central corridor. Unlike the situation in Rwanda, where there is a system of authorized carriers for the transport of petroleum products from Nairobi, there are no restrictions of this kind in Burundi to bar new transporters from entering the market. The Burundian transport capacity, dominated by private operators, is reported to be plentiful, so much so that the Government yielded to pressure to regulate transport prices some years ago. 22/ Developments since then led to a reduction in 1989 of the official rates and, as mentioned earlier, the Government has now committed itself to deregulate international transportation rates.

4.26 Over the longer term, the central corridor railroad/barge alternative holds promise for further cost reductions. The difficulties of Tanzania Railway Corporation (TRC) in maintaining a reliable service are due to managerial problems, shortages of locomotives and tank-wagons, poor rotation of the latter and badly maintained tracks. As shown in Table 4.2, the share of the central corridor and thereby Dar es Salaam as a supply alternative has fallen in recent years, due to the road and railway conditions mentioned above, and was only 8% in 1988.

Table 4.2: IMPORT OF PETROLEUM PRODUCTS BY SUPPLY ROUTE
(%)

	1985	1986	1087	1988
Mombasa	74	69	90	92
Dar es Salaam	25	29	10	8
Zambia	1	2	a)	a)

Source: Direction Générale du Commerce.
a) Less than 0.5%.

22/ *According to SEP, there were in 1988 173 registered Burundian tank trucks that transported 96% of Burundi's imports of petroleum products (i.e. 4% on foreign trucks). On average, the trucks made 8.5 trips that year to (mainly) Nairobi while more efficiently used trucks made 22 trips that year (and this is not a maximum). This shows an underutilization of the transport capacity and the resulting competition has led the transporters to granting discounts on the official prices.*

4.27 The deterioration of the equipment and service of TRC has been the subject of concern for the EEC, the Bank and other international organizations. According to the Great Lakes Corridor Study (World Bank, 1989), this situation may be ascribed to the fact that transit traffic in both East and Southern Africa has been volatile and that it may therefore not be in the financial interest of TRC nor in the economic interest of Tanzania to invest for traffic which could revert to other routes. It could, however, be in the interest of all parties if the additional capacity was provided by the landlocked countries themselves. On the other hand, the Tanzanian Government and TRC have been reluctant to accept foreign rolling stock for the dedicated use of foreign traffic. The problem appears now to have been overcome, and the Bank and EEC are parallel-financing a project the objective of which will be to create reliable transport of goods (block trains) for the landlocked countries from the port of Dar es Salaam via the central line to Kigoma. Through improvements in the regulatory framework and in the management of TRC as well as investments in infrastructure and equipment, service and reliability should improve significantly and make the central corridor a cost-effective alternative for Burundi in 2-3 years time. As the project is based on a commercial concept, with negotiations involving, inter alia, port authorities, TRC and the petroleum companies, no investments are expected on the part of the Government of Burundi. The present barge capacity on Lake Tanganyika is sufficient to take significant increases in load.

Least Cost Supply

4.28 The least cost supply takes into consideration the combined cost of the product landed at the oceanic port and overland transport. In the case of Burundi, the overland transport element (including throughput fees) represents 36% (or US$137/Mt) of the cost CIF Bujumbura when using the railway/barge alternative of the central corridor, 51% (US$254/MT) for the road alternative of the central corridor, and 52% (US$262/MT) in the case of the northern corridor (including pipeline costs). As shown in Annex 4.4, with equal product costs and import margins in the three cases the savings are considerable in the case of the central corridor alternative via Kigoma (and probably also for the road alternative from Dar es Salaam expressed in economic terms). 23/ With sufficient capacity and reliability the railroad alternative would therefore be the preferred option. As indicated above, however, until around 1993 and the strengthening of the railway option probably only around 10% of Burundi's requirements for petroleum products can be satisfied by this route.

4.29 In the meantime, not much can be accomplished in terms of savings in transport costs except that the commitment on the part of the Government of Burundi to deregulate the truck transport should be followed up in practice by letting the importers choose transporters (domestic or foreign) and negotiate rates freely, as indicated earlier. In addition, the use of the shorter and less expensive central

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23/ *The size of the savings in transportation costs for Burundi after 1993 are difficult to estimate since the rates presumably would be the result of negotiations on commercial terms.*

corridor road alternative is expected to be encouraged as longer parts of it are paved. For supply safety reasons, however, both road options, the northern as well as the central corridor, must be kept open.

4.30 As for the sources of supply, the options open to Burundi other than the ones used at present are, as discussed earlier, in practice limited. There are, nevertheless, initiatives that can be undertaken without delay to modify the present supply arrangements with a view to reducing costs (although constraints will also apply with respect to source option, until capacity along the central corridor is increased).

4.31 No Burundi petroleum operator alone has enough edging power to achieve improvements in the present supply arrangement. An alternative, however, would be to combine the purchases of all the importers in Burundi and, thus, instead of purchasing annual volumes of 10,000 MT of products individually they would be negotiating, say, 50,000 MT. Demand above this quantity would be left for supply via the Kigoma route due to the substantial economies on transport. It is estimated that savings of at least US$20/MT (or close to BUF 2.5/l) in product cost could quite likely be made (see Annex 4.5) following a course of action indicated below. On the other hand, there may be costs and risks associated with such an arrangement which have also to be considered.

4.32 It is recommended that the Government open a dialogue with the petroleum operators in Burundi and establish a task force, the mandate of which would be to prepare a price reduction strategy, enter into negotiations with possible suppliers in Kenya and Tanzania, and evaluate the benefits (cost savings) and potential drawbacks of a pooling arrangement. The task force should include representatives from the MEM, the MCIA, and the petroleum operators, and be assisted by a petroleum consultant. 24/ If the overall assessment, to be submitted to the Government, is positive and accepted the task force would finalize negotiations on behalf of the Government and the local oil companies for the supply of petroleum products to be consumed in the country over a period of two years, in total approximately 100,000 MT, subject to a schedule of timing and products to be indicated. A similar strategy has been used elsewhere with success.

4.33 One of the factors that has to be taken into account in the overall evaluation of such a scheme is alternative supply routes and sources since a concentration of purchases increases the vulnerability in case of interruptions related to the blocking of transportation through one of the neighboring countries. The contract entered into with the chosen supplier must contain clauses that permit the use of alternative sources and routes in case of force majeure.

4.34 The task force would contact specifically the refinery in Mombasa, proposing the purchase of products or a throughput fee for products to be bought in the international market, and approach BP and Esso in Dar es Salaam. The final decision on the arrangement itself and the specific supplier would be

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24/ *The Government lacks expertise to carry out complex negotiations with the Burundian operators or with the refineries and/or multinationals in Nairobi/Mombasa and Dar es Salaam. It would therefore have to engage for a period of time an international petroleum expert with experience in trading and in high level negotiations.*

made on the basis of the negotiations, on considerations as to transport options and costs, and on the risks and impacts indicated in the previous paragraph.

Price Structure and Taxation

4.35 The retail prices of gasoline, diesel and kerosene remained unchanged between 1983 and 1990. The price of gas oil has been adjusted several times, but the overall increase since 1980 has only been 20%. The Government has strongly resisted any attempts to liberalize the prices of petroleum products and has adjusted its duties and taxes to compensate for variations in product prices and the exchange rate. Between 1983 and 1990, the fall in international oil prices was offset by the fall in the Burundian franc vis-a-vis the US dollar. In September 1990, however, the price of petroleum was increased by about 30%.

4.36 A yard-stick for petroleum product prices is the approximately US$100 per barrel of premium gasoline in Burundi. This price includes all taxes and duties and may be high when compared to the prices in the United States but similar to the ones in most of Europe and lower than in Burundi's neighboring countries. A breakdown of the price of gasoline imported from Nairobi shows that of the close to US$100 in retail price for gasoline, US$26.00 are product costs, US$30.40 are overland transport to Bujumbura, US$15.50 are marketing margins and depot fees, and US$27.60 government revenues. Thus, relatively moderate government revenues appear to compensate for the high product and transport costs. In August 1990, the retail price of gasoline in Rwanda, with roughly the same cost CIF Kigali as CIF Bujumbura, is around 40% higher than in Burundi, basically because the government revenue is twice as high per liter as in Burundi. (This difference is reduced to a 60% higher government take in the case of Rwanda, compared to gasoline to Burundi that arrives via the modestly used Kigoma route since the lower transport cost increases the Government's share.) A comparison of petroleum products in Burundi shows a fairly uniform level of taxation (the percentages quoted apply to products arriving via Nairobi): gasoline 29%, diesel 25%, kerosene 17%, fuel oil 26%. Government duties and taxes on petroleum products amounted in 1988 to some BUF 1.2 billion, or around 5-6% of total fiscal revenue (95% comes from duties and taxes specifically on gasoline and diesel).

4.37 For various reasons a revision of the price structure of petroleum products and a review of the level of prices are desirable:

(a) To encourage economic efficiency in the use of fuel by keeping prices in line with the international level and to increase public revenues, it is recommended (i) that the present system of frozen prices be discontinued and that retail prices should be allowed to vary with the CIF Bujumbura cost, adjusted at appropriate time intervals, and (ii) that petroleum product taxation and prices be reviewed and generally increased, based on the view that the Burundian franc is overvalued, 25/ that there is a need to increase government revenue (see below), and that the level of government taxation and prices of

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25/ *A preliminary estimate is 20%, reducing prices and taxation of petroleum products in real terms.*

petroleum products in the neighboring countries is higher. 26/ For this purpose a study would be required which should also examine the question to what extent there should be a greater differentiation in taxation of petroleum products, from an economic and a social point of view. However, the system of ceiling prices should be retained, at least for the time being, as there is strong political resistance against freeing prices on commodities considered to be of strategic importance; and

(b) The price structure itself should be reviewed with the objective of simplification and modification of certain of the tax elements in the structure (see Table 4.3 for some initial changes and also Annex 4.6 for more specific comments to the individual items). The main changes proposed at this stage (but subject to further study, as indicated above) are (i) to double the road user charge for gasoline and diesel as a first step to better reflect the funds needed for road maintenance and rehabilitation, estimated at BUF 800 million annually (to be followed by annual revisions of the rate to reach the necessary level), and (ii) replace the present "fonds de regularisation" and "fonds special carburants" by a single "taxe national carburant" of an increased amount as shown in Table 4.3. A fixed tax of this kind, to be reviewed annually, is proposed rather than an ad valorem tax, since in the latter case the tax would vary frequently with variations in the CIF cost and make government budgeting more unpredictable and revenues more subject to external forces.

4.38 The proposed changes are preliminary and indicative only, since the question of price level and taxation must be seen in conjunction with the proposal for letting international price variations be reflected in domestic prices, furthermore, with the proposed initiatives to negotiate lower product prices with suppliers in Mombasa and Dar es Salaam, as well as with the Government's needs for revenue and the real level of taxation. Finally, the new price structure must take into account the incentives to the importers to seek the transport route which is the least cost from a national point of view.

4.39 The urgency of reviewing and revising the price level and structure is underscored by the oil price increases since August 1990. The situation requires an initiative by the Government to introduce a regime of adjustable petroleum prices based on import parity.

26/ *This, as mentioned in para. 4.4, contributes to illegal exports to neighboring countries.*

Table 4.3: INDICATIVE MODEL FOR THE PRICE STRUCTURE OF PETROLEUM PRODUCTS
EXAMPLE: GASOLINE FROM DAR ES SALAAM VIA KIGOMA

		August 1990 (a)	Proposed
A)	Price CIF Bujumbura		
	US$/MT	277.91	277.91
	BUF/l	44.48	44.48
B)	Customs duties/official fees		
	Droits d'administration	0.31	0.31
	Droits d'entree	1.65	1.65
	Taxe de service	1.78	1.78
	Patente	0.22	0.22
	Sub-total	3.96	3.96
C)	Transit in depot		
	Fee SEP	1.20	-
	Unloading	0.20	-
D)	Cost price (A+B+C)	49.84	48.44
E)	Wholesale margin	11.50	12.90
F)	Taxes		
	Fonds routier national	5.00	10.00
	Fonds de regularisation	6.00	-
	Fonds special carburants	24.16	-
	Taxe national carburants	-	40.16
	Sub-total	35.16	50.16
G)	Wholesale price	96.50	111.50
H)	Retail margin	3.50	3.50
I)	Retail price	100.00	115.00

(a) In September 1990, the price of gasoline was increased to BUF 135 per liter and the levy for the National Road Fund to BUF 10 per liter. The National Hydrocarbon Levy was not adopted. The Special Hydrocarbon Fund Levy changed in keeping with the CIF price.

Source: Direction Générale du Commerce; mission.

Conservation and Substitution

4.40 The strain on the country's external balance represented by oil product imports and the expected continued increase in quantities coupled with uncertain outlooks for Burundi's main export products, call for initiatives aiming at containing the growth of imports of oil products without disruptive effects on the economy or undue negative impacts on people's welfare. Two general avenues are in principle available: improving efficiency in the use of petroleum products and substituting national energy sources for oil products. The scope for applying such measures is generally limited by the composition of demand, the availability of suitable indigenous energy resources as well as of accessible technologies that can be successfully applied under the circumstances.

4.41 As mentioned in Chapter VI, peat is available in large quantities, mainly from lowland bogs. Although today in use basically in government institutions and in cottage industries where it mainly replaces woodfuels, there is a scope for using peat as a substitute for fuel oil in some larger industrial

establishments, such as a textile factory, a brewery and a bottle factory. Savings in fuel oil per entity would represent a quite significant share of total national consumption and preliminary calculations show that conversions could be financially attractive. A step-wise approach is recommended in Chapter VI, commencing with a feasibility study in a selected industry.

4.42 A study of energy consumption in 15 of the largest industrial enterprises in Burundi was carried out in 1986 on the initiative of the EGL (Energie des Pays des Grands Lacs) and with the support of the French Cooperation. The study identified a number of possible measures to improve specific efficiency of energy end-use, particularly for fuel oil and diesel. These measures, of the conventional type (reduction of excess air, preheating, automatic regulation devices, etc.) could lead to small but not insignificant savings. Unfortunately, no follow-up resulted from the study and it is therefore recommended that the DGE consider the steps and the costs necessary for implementation. The Government could encourage the implementation through measures of two kinds:

(a) granting financial support for advisory assistance to help industry acquire and install metering and regulating devices; and

(b) increasing taxation of fuel oil to encourage industrial operators to make energy savings; such a measure should be considered in the broader context of the recommended study of petroleum product prices and taxation.

Security Stocks

4.43 In addition to its operational stocks of petroleum products, stored at SEP, in the tanks of service stations and with large consumers, Burundi - in particular as a landlocked country - requires security stocks to ensure an uninterrupted supply with a reasonable degree of probability. During periods in the past the country has experienced supply problems. The reasons for these have varied but generally the main causes for disruptions in the future could be:

(a) supply problems in the international market, although these would under the present circumstances not justify any particular measures;

(b) political disturbances or even military actions in the region;

(c) problems with respect to overland routes used to transport petroleum products, due to temporary inaccessibility or to capacity problems on the railway. Included in this should also be the possibility of enforcement of maximum axle loads in neighboring countries which is not the case at present; and

(d) unavailability of foreign exchange needed to open confirmed letters of credit to pay for the products.

4.44 The size of reasonable security stocks will be the result of an assessment of the above and other factors over time, the evaluation of the risk elements being largely qualitative. Against this, the cost of holding idle stock and the possibility of airborne supplies during a crisis will tend to reduce what a developing country with limited resources can and should spend to avoid stockout. It is difficult at present to envisage a scenario for Burundi that would justify security stocks of more than 30 days' consumption. The security stocks would come on top of normal operational stocks in Burundi of 20-30 days' consumption, which would mean total stocks at any time corresponding to roughly 60 days. The Government should see to that such a policy is enforced. The storage capacity of SEP together with smaller outside depots and the capacity of service stations are in aggregate large enough to comply with such a regulation. The cost of the additional 30 days' stock (roughly US$ 2 mill at CIF prices in initial costs) should be borne by the consumers and an item to cover this should be included in the official price structure (amounting to approximately BUF 0.5/l levied on the consumption of all petroleum products).

4.45 It is therefore recommended that:

(a) the Government open a dialogue with the petroleum operators with a view to implementing a policy of 30+30 days' product stocks and to studying the question of financing and cost coverage of the security stocks;

(b) the Government should initiate discussions with the owners of SEP regarding the possibility of having SEP operate the Gitega depot from the point in time dictated by the need to expand security stocks, rather than implementing the currently planned purchase of 3,000 m3 of products to be stored in the near future at the Gitega depot; and

(c) the Government prepare a contingency plan for the utilization and replenishment of the security stocks related to possible interruptions of supplies, including the identification of key petroleum product-dependant activities.

Oil Exploration

4.46 The major part of Burundi's territory is covered by basement rock. Only the Ruzizi Plain, a 200 km portion of the Tanganyika Graben is sedimentary. Asphalt seepages along the shores of Lake Tanganyika suggest the existence of rocks capable of containing hydrocarbons. This has been confirmed by seismic investigations followed by an aeromagnetic survey. A contract was signed between the Government and the American oil company, AMOCO, and three exploratory wells were drilled in 1987. Traces of hydrocarbons were found but the results were apparently inconclusive and AMOCO has been planning further exploratory work offshore in Lake Tanganyika. However, due to the depths of the waters and to the until recently relatively low prices of crude, AMOCO has been hesitant to pursue further activities alone and is looking for partners to share the risk. At present, the major petroleum companies are holding back on investments in new exploration areas in Africa, preferring zones and exploring blocks with confirmed crude potential and known production costs.

Institutional Changes

4.47 Although petroleum products are commodities like a host of others imported to Burundi, the particular issues raised in connection with the supply and distribution of them and their importance in a larger energy context, would probably be more suitably addressed by a modified institutional arrangement compared to the present one, where the Direction Generale du Commerce (DGC) has the responsibility with little involvement of MEM. The issues related to supply and supply arrangements, distribution, storage and security stocks, and pricing require both capacity and expertise of a kind which the Government at present does not possess. Although these would have to be acquired also by the DGE, the energy-related issues and nature of petroleum products indicate that these would probably be better handled within the framework of this organization, but in cooperation with the DGC.

4.48 It is therefore recommended that a petroleum unit with functions as indicated in the previous paragraph and detailed in Annex 4.7 be created within the DGE, 27/ that technical assistance as indicated earlier related to supply and pricing issues and for training to build up local expertise be sought, and that close cooperation with the petroleum operators be initiated. An alternative to creating a new unit would be to expand the present role of the Departement des Projets in the DGE (especially with REGIDESO, taking on increased responsibilities for power sector projects and planning (see Chapter V)).

Recommendations

4.49 The main recommendations of the mission in the petroleum subsector are as follows:

(a) In cooperation with the petroleum operators in Burundi the Government should prepare a strategy for reducing petroleum product prices by considering an option of pooling purchases and entering into negotiations with possible suppliers in Kenya and Tanzania. For this purpose a task force headed by the Director General of Commerce should be established and the assistance of a petroleum expert with international experience be sought. Other possible supply arrangements should be considered as they become an option, including regional solutions which are at present under study;

(b) The Government should monitor transport options in the light of improvements in infrastructure, equipment and institutional arrangements, in particular the railway alternative from Dar es Salaam, and see to it that the incentives work to stimulate the use of the most economical alternatives. The Government should put into practice the decision to deregulate the truck transport industry as agreed with the Bank;

(c) Retail prices for petroleum products should be allowed to fluctuate with the movements in the international market and initiatives should be taken promptly to start the process

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27/ *This was proposed also in a study in 1984: Burundi: Review of Petroleum Import and Distribution Arrangements (Energy Sector Management Program).*

of increasing prices. Petroleum product prices and levels of taxation should be reviewed and the official price structure should be revised, with a view to mobilizing resources for general and for specific user-related purposes, encouraging efficiency in the use of fuel, and simplifying the structure itself. External assistance for the analytic and implementation work related to the pricing study should be sought;

(d) The possibilities for substitution of indigenous peat for fuel oil in industrial establishments should be pursued, as recommended in Chapter VI, by establishing the technical, financial and economic viability of the option and, if confirmed, by choosing a step-wise approach as indicated;

(e) Greater efficiency in the use of petroleum products should be promoted by the Government by supporting advisory services to industrial establishments to assist them in following up on the already recommended measures on energy consumption in industrial enterprises, and by considering price increases for fuel oil;

(f) A policy of security stocks should be defined and implemented in cooperation with the petroleum operators, based on a concept of 30 days' operational stocks plus 30 days' security stocks. A plan for the financing and cost coverage of the latter stocks, as well as for their use and replenishment, should be prepared. Finally, the future use of the Gitega depot should be planned and discussions with the owners of the SEP depot be initiated for the common management of the two facilities from a point in time required; and

(g) Greater involvement by the DGE is proposed with respect to supply arrangements, storage, pricing, and conservation of petroleum products, and a unit with local expertise should be established and developed with external technical assistance in the initial phases. The unit should carry out its functions in cooperation with the DGC and with the local petroleum operators as partners in seeking to reduce costs and increase supply security of petroleum products.

V. ELECTRIC POWER

Organization of the Electricity Sector

5.1 The production, transmission and distribution of electricity in Burundi is the responsibility of the Régie de Production et de Distribution d'Eau et d'Electricité (REGIDESO) and of the Direction Générale de l'Hydraulique et des Energies Rurales (DGHER). REGIDESO is a wholly Government-owned public enterprise, created by a decree dated October 2, 1968, and placed under the administrative control of the Ministère de l'Energie et des Mines. Another decree published on March 11, 1986 eliminated the monopoly that REGIDESO had in the distribution of electricity and established its responsibility only in important urban centers. DGHER is a department of the Ministère du Développement Rural (MDR) which is in charge of electrification in rural areas. In practice, the limits between both institutions are not well defined and REGIDESO operates beyond the important urban centers defined in the decree of March 11, 1986.

5.2 Burundi, together with Zaire and Rwanda, is a shareholder of the Société Internationale d'Electricité des Pays des Grands Lacs (SINELAC), created in 1983 to construct and operate the Ruzizi II hydroelectric power plant and other possible future plants on the Ruzizi river. The Société Nationale d'Electricité du Zaïre (SNEL) owns not only the Ruzizi I hydroelectric power plant located on the border between Zaire and Rwanda, but also the transmission line from Ruzizi I to Bujumbura and a power sub-station located in Bujumbura. Burundi, together with Tanzania, Rwanda and Uganda, also belongs to the Organisation pour l'Aménagement du Bassin de la Kagera (OBK), which is responsible for the development of the future Rusumo Falls hydroelectric power project.

Demand for Electricity

5.3 The consumption of electricity in Burundi reached a level of 105.3 GWh in 1988 and of 102.2 GWh in 1989 (see Table 5.1), representing a per capita consumption of around 20 kWh, one of the lowest values in the world. Only 1.5% of the total population uses electricity and 82% of the total consumption is concentrated in Bujumbura. Sales by REGIDESO are 92% of the total, while auto-producers account for about 7% of consumption and the DGHER for about 1%.

5.4 The average annual rate of growth of consumption was 10.8% in the period 1980-1988 and 6.8% in the period 1985-88. In 1989 there was a decline in the consumption of electricity of around 3.0%, which is explained by the temporary closing of the most important consumer (VERRUNDI-bottle manufacturer) and a general decline in industrial activity. Industry and commerce account for about 47% of the total consumption and their share has increased regularly over the years (in the case of REGIDESO from 34% in 1980 to 48% in 1988).

Table 5.1: CONSUMPTION OF ELECTRICITY
(GWh)

Supplier	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
REGIDESO	41.4	45.7	49.5	60.4	67.3	80.4	79.9	93.1	98.4	93.8
Low voltage	(19.8)	(21.7)	(23.5)	(27.5)	(29.0)	(47.9)	(46.4)	(36.9)	(40.2)	(43.5)
Medium voltage	(21.5)	(24.0)	(26.0)	(32.9)	(38.3)	(32.5)	(33.5)	(56.3)	(58.2)	(50.3)
DGHER	0.0	0.0	0.1	0.1	0.2	0.4	0.6	0.7	0.8	0.9
Other	5.0	5.1	5.3	5.4	5.5	5.7	5.8	5.8	6.1	7.5
Total	46.4	50.8	54.8	65.9	73.1	86.4	86.4	99.6	105.3	102.2

Source: EDFI, Power Sector Master Plan, and REGIDESCO

5.5 The number of consumers supplied has grown from 5,408 in 1980 to 13,799 in 1989, with an average annual growth rate of 10.6%. The DGHER has 362 users, and REGIDESO 13,437, of which 13,283 are low voltage and 154 medium voltage. The number of new clients connected to the system of REGIDESO was 645 in 1988 and 1,507 in 1989. The increase is explained by the new policy on connections established under the plan for the reform of the institution. The 10 largest users of electricity are VERRUNDI (bottle manufacturer), COTEBU (textiles), BRARUDI (brewery), BRAGITA (brewery), OCIBU (coffee), the University of Burundi, three hotels in Bujumbura and REGIDESO itself. In a normal year, these users account for about 45% of the total consumption of electricity.

5.6 Consumption per domestic household is estimated at 2,300 kWh per year and has declined systematically over the years. This phenomenon is explained by the fact that the expansion of electrification progressively reaches lesser development areas with lower household incomes. Given the low proportion of the population which, at the present time, has access to electricity, this trend is likely to continue in the future.

5.7 Before 1980, only two towns (Bujumbura and Gitega) had electric service. At the end of 1989, there are 54 urban centers with electricity (see Annex 5.1), of which 25 are linked to the interconnected grid. While Bujumbura has about 230,000 inhabitants, the next four towns (Gitega, Ngozi, Kayanza, Rumonge) have only between 10,000 and 20,000 inhabitants. There are only 18 urban centers with a population of more than 5,000. This pattern of settlement is very unfavorable to the objective of increasing the access of the population to electricity services, and makes a properly designed rural electrification policy of particular importance to the country. However, the extension of electricity in rural areas will be costly and difficult due to the low number of rural villages and to the fact that the vast majority of farmers live in dispersed homesteads.

5.8 Another major obstacle to expanding the number of consumers has been the high cost of a connection. Until July 1989 all new users had to make a lump-sum payment equivalent to the cost of the individual connection plus a contribution towards the extension of the grid. Since high-standard imported materials were used, the costs were quite high. Average connection charges have been

estimated at about BUF80,000 (between US$500 and US$750). In 1989 these charges were decreased to cover only the individual connection and term payments of up to 24 months were allowed. Equipment has been imported from some low-cost South-East Asian countries. Average connection charges have thus decreased to about BUF35,000 (US$220) and explains the high number of new users connected in 1989. Nevertheless, the electrification rate in Bujumbura is estimated to be only around 20% and a substantial number of connections requests remains unfulfilled because of deficiencies in the supply of materials and in organization and planning. The new connection policy of REGIDESO should be continued but the internal organization and planning for the execution of connections needs to be improved. Several donors active in Burundi with respect to the financing of new extension lines allow only the use of high-cost imported equipment and materials from donor countries, instead of low-cost equipment from more advanced developing economies. Such practices should be discontinued to permit more cost-efficient expansion of the system, at the same time as donors should be encouraged to include the financing of connections in their distribution programs.

Demand Forecast

5.9 The most recent detailed projection of demand was done by Electricité de France International (EDFI) in December 1988 in the context of the Power Sector Master Plan. The study considers four different sectors (households, commerce and small industry, large industry, and public services), and two separate regions (Bujumbura and the rest of the country). It presents two scenarios: (a) a low-growth demand scenario based on a growth of GNP of 4% until 1995 and 3% after that year, population growth of 2% per year and a moderate electrification policy, and (b) a high-growth demand scenario with a growth of GNP of 5% until 1995 and 4% after that, population growth of 3% and an intensive electrification policy to reach 4% of the population by year 2005. Total electricity consumption would grow at an average rate of 7.3% per year in the low-growth scenario and at 8.8% in the high-growth scenario, without considering the conversion to electricity of industrial boilers or large electricity-intensive new projects.

5.10 The EDFI study overestimates the consumption per household compared to recent actual figures. The comparison of the projections with actual figures results in an overestimation in 1989 of the order of 31% for the low-growth scenario (122.7 GWh vs. 93.8 GWh) and of 47% for the high-growth scenario (138.1 GWh). The conclusion is that a year after their publication the projections of EDFI are not useful, even when correcting for the temporary closing of the largest user in 1989.

5.11 The growth of consumption must distinguish between old and new users. A more intensive use of electricity by old users will depend on the prospects for economic development and for growth of personal incomes. Given the situation on the international market for coffee and of public finances, growth of GNP will be moderate in Burundi in the near future (around 4% per year) and the consumption of electricity of existing users will only show small increases. The possibilities of growth are mainly found in increases in the rate of electrification, with a deliberate and decisive policy of substantially increasing the number of new connections. However, this policy is affected by the organizational and planning deficiencies of REGIDESO, by its difficult financial situation and by the lack of donor financing for new connections.

5.12 The situation described in the preceding paragraphs indicate that statistical methods are not appropriate for projecting the future evolution of the consumption of electricity in Burundi. Growth will depend fundamentally on future actions of the Government and REGIDESO with respect to supply and connections and on the (unlikely) connection of new large industrial consumers within the forecast period. Based on these and other factors, an average growth rate of 6% per year has been applied for planning purposes. This rate is similar to the rate observed between 1985 and 1988 and has been obtained using the methodology of EDFI with some more realistic values of the fundamental parameters. If there were to be operating problems in some of the existing big industrial users (VERRUNDI, COTEBU, BRARUDI), growth will be smaller. On the other hand, if economic growth occurs at a faster rate and the increase in the number of new users is substantially accelerated, the consumption of electricity would probably be larger. Annex 2 gives a comparison of the demand projections used in this report with other previous projections of consumption. It must be noted that differences are mostly explained by divergences in the consumption of the base year and not by differences in growth rates.

5.13 Production requirements are estimated on the basis of a gradual decrease of total losses from the level of 20% observed in 1989 to 15% by 1995 and to 12% by 2000 (for discussion of losses, see paras. 35 and 36). Peak demand is calculated on the basis of 5,100 hours of utilization. The values of consumption, production and peak demand for the period 1989 - 2000 are given in Table 5.2 for the electric system of REGIDESO.

Table 5.2: REGIDESO - FUTURE DEMAND FOR ELECTRICITY

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Consumption (GWh)	93.8	99.4	105.4	111.7	118.4	125.5	133.1	141.0	149.5	158.5	168.0	178.1
Production (GWh)	117.3	124.3	130.1	136.2	142.7	149.4	156.6	164.0	173.8	182.2	193.1	202.4
Peak demand (MW)	23.0	24.4	25.5	26.7	28.0	29.3	30.7	32.2	34.1	35.7	37.9	39.7

Source: Mission estimates.

5.14 Based on the above indicated demand projections, energy and capacity balances for Burundi were constructed and are presented in Annex 5.3. These balances indicate that for the next ten years peak demand capacity should not be a constraint in the system. While the capacity balances were done with the installed capacity of the hydroelectric power plants, the hydrological analysis in the Power Sector Master Plan indicates that in most cases this capacity is guaranteed for the peak demand period. Although reserve capacity will be low at the end of the period, the next power plant would be justified primarily on the basis of the energy requirements in the system.

5.15 The guaranteed energy from existing domestic hydroelectric plants is estimated at 102.0 GWh, and the energy available to Burundi from Ruzizi I and Ruzizi II is at least 59.7 GWh. In this situation, existing plants and imports can satisfy all consumption requirements until 1995. However, REGIDESO is negotiating with SNEL an increase in the energy available from Ruzizi I and a recent study about hydrology in the region indicates an increase in the available energy to Burundi from Ruzizi II with two units to 65.6 GWh (SINELAC, Réévaluation du Productible de la Centrale Hydroélectrique Ruzizi II,

II, February 1990). These would indicate that an additional power generating plant would not be needed before 1998. If the third unit of Ruzizi II (13 MW) is added before that date, the need for new plant may even be postponed for another year.

Generating Capacity

5.16 Total production of electricity in Burundi was 124 GWh in 1988 and 126 GWh in 1989, of which 116.6 GWh and 117.3 GWh, respectively, from the system of REGIDESO. There are 27 hydroelectric power plants in operation in the country with a total installed capacity of 32.2 MW. REGIDESO operates seven plants with a total installed capacity of 30.6 MW, which represents 95% of the total. Two of these plants (Rwegura with 18 MW and Mugere with 8 MW) represent 81% of the total installed capacity in the country. The DGHER operates eight plants with a total capacity of 0.8 MW and auto-producers, most of which are religious missions, have 12 hydroelectric power plants with a total installed capacity of 0.8 MW. Of the total hydroelectric power plants, 18 have an installed capacity of less than 200 kW (see Annex 5.4) and can be classified as micro-hydro.

5.17 The principal characteristics of the hydroelectric plants above 200 kW are given in Table 5.3. With the exception of Rwegura, these plants are run-of-river with a good utilization of their installed capacity (6,000 to 8,000 hours per year). Rwegura has a reservoir of 17 million m3, and can be used with a year-long guaranteed power of 8 MW for approximately 8 hours per day. Mugere can guarantee 8 MW for about 4 hours per day. For the other plants, guaranteed power is almost equal to installed power.

Table 5.3: CHARACTERISTICS OF HYDROELECTRIC POWER PLANTS

Plant	Operator	Installed Capacity (kW)	Guaranteed Power (kW)	Average Energy (GWh)	Guaranteed Energy (GWh)	Year Installed
Rwegura	REGIDESO	18,000	6,300	56.6	55.2	1986
Mugere	REGIDESO	8,000	2,200	47.3	19.0	1982
Ruvyironza	REGIDESO	1,275	1,200	11.0	10.5	1980/1984
Nyemanga	REGIDESO	1,400	1,400	12.2	12.2	1988
Gikoro	REGIDESO	850	240	6.8	2.1	1982
Kayenzi	REGIDESO	800	150	2.2	1.3	1984
Butezi	DGHER	240	ND	ND	ND	1989
Buhiga	DGHER	240	150	2.0	1.2	1984
Marangara	REGIDESO	240	220	2.0	1.9	1986

Source: EDFI, Power Sector Master Plan.
ND = no data.

5.18 Besides the domestic power plants, Burundi takes hydroelectric energy from Ruzizi I and Ruzizi II. Ruzizi I is owned by the Société Nationale d'Electricité (SNEL) of Zaïre, has an installed capacity of 28.2 MW (two groups of 6.3 MW in operation since 1958, and two groups of 7.8 MW in operation since 1972), and its average available energy is estimated at 148 GWh per year. A

rehabilitation of this plant has been recently completed. Burundi receives the energy from Ruzizi I free as repayment of debt by SNEL to REGIDESO and to the Banque de la République du Burundi (BRB). Payments for the first debt are fixed at 12.8 GWh per year until July 2005, while for the second one they are 17.6 GWh per year until June 1991. However, REGIDESO has over the years not consumed all the energy that is due, and SNEL has therefore accumulated debt over and above what is established in the agreements. At the end of 1989, the balance to be paid by SNEL was 66.8 GWh relating to the agreement SNEL/BRB and 255.3 GWh on the agreement SNEL/REGIDESO.

5.19 Ruzizi II is operated by the Société Internationale d'Electricité des Pays des Grands Lacs (SINELAC) and jointly owned by Burundi, Zaire and Rwanda. It started operations in July 1989 with two units and a total installed capacity of 26.6 MW. Average available energy is estimated at 141 GWh per year, of which REGIDESO is assumed to use one third. As was indicated above, recent studies have increased the estimates of available energy to 197 GWh with two units and 223 GWh with three units. The price established by SINELAC is SDR0.0285 per kWh, but this does not comply with the agreements with the World Bank that financed the project and discussions are underway for its revision. A tariff that reflects long-run marginal cost with production equal to average energy and a 10% discount rate is SDR0.059 per kWh. Table 4 gives the energy imported by Burundi from Ruzizi I and Ruzizi II from 1980 to 1989. The declining use of energy from Ruzizi I reflects increased domestic capacity, essentially from Rwegura.

5.20 REGIDESO has ten thermal power plants (diesel) with an installed capacity of about 10.0 MW. Several of these groups are old, and it is estimated that only about 5.0 MW are really available. The largest thermal plant is in Bujumbura and has a nominal capacity of 7.4 MW, but since several of its units date from 1953/54, the available reserve capacity they provide to the electric system is about 3.0 MW. The production of electricity from the thermal plants of REGIDESO is about 2% of total production and is likely to decline as some additional isolated centers are connected to the electric grid. Thermal units installed by auto-producers have an estimated capacity of 6.3 MW, with the largest units in some tea factories (Tora: 456 kW, Rwegura: 468 kW, Teza: 375 kW).

Table 5.4: Burundi - IMPORTS OF ENERGY
(GWh)

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Ruzizi I	43.2	46.3	34.2	20.3	34.9	42.4	26.5	12.6	12.3	1.8
Ruzizi II	-	-	-	-	-	-	-	-	-	12.1

Source: REGIDESO

Transmission and Distribution

5.21 A map in the back of the report shows the power network of Burundi. The interconnected system includes the provinces of Bujumbura, Bubanza, Cibitoke, Kayanza, and Ngozi, and the localities of Tora and Mugamba in the provinces of Bururi and Gisozi, Mwaro and Kibumbu in the province of Muramvya. Gitega and Muramvya will be incorporated in 1991 when the 110 kV

transmission line between Bujumbura and Gitega is completed. The principal transmission lines are the 110 kV lines from Ruzizi II and Rwegura to Bujumbura (RN1), the 70 kV line from Ruzizi I to Bujumbura (SNEL), the 35 KV line from Mugere to Bujumbura (Ozone) and the 30 KV lines that feed Kayanza, Ngozi, Ijenda, Tora and other localities.

5.22 While the interconnected network is being expanded radially, there are two separate sub-systems under development. The one in the south will interconnect Nyanza Lac, Rumonge, Makamba, Rutana, Gihofi and Bururi with the Nyemanga hydroelectric power plant (1.4 MW) through 30 kV transmission lines. The other one is in the north-east and will connect Cankuzo, Muyinga, Karuzi and Kirundo with the micro-hydropower plants of Murore (24 kW), Kayenzi (800 kW), Buhiga (240 kW), and Marangara (240 kW), also through 30 kV transmission lines.

5.23 The total length of high and medium voltage lines is estimated at 820 km, and its classification by tension is presented in Table 5.5. The indicated 150 km of 6.6 kV lines are all underground lines in Bujumbura and Gitega. The low voltage distribution system can be estimated at about 300 km, of which 100 km are underground.

Table 5.5: HIGH AND MEDIUM VOLTAGE LINES

Voltage (kV)	Length (km)
110	126
70	112
35	14
30	329
15	12
10	75
6.6	150

Source: REGIDESO.

5.24 There are no technical norms in Burundi for electrical works and the standards applied are normally those of the builders. This explains, for example, the utilization of a voltage of 35 kV for the transmission line Mugere - Bujumbura (Ozone), which requires special transformers and equipments and a special stock of spare parts. The 30 kV voltage for transmission lines outside the main urban centers is adequate, given the distances and the power to be transported. The 10 kV voltage for the transmission within the urban centers is also adequate, but the 6.6 kV voltage used in Bujumbura and Gitega has reached its limits and changes in the voltage to 10 kV may be necessary and are under study.

5.25 The use of imported steel posts, instead of locally available wood ones, seems to be imposed by foreign consultants and donors without a complete analysis of the advantages and disadvantages for the country. The experience of other countries indicates that it is possible to have adequate treatment for wood posts. Similar cases are those of electric light meters, where high-cost European models have been used, and of cables, where those with a steel core have been used instead of all aluminium conducting cables. In some instances, tri-phase connections have been installed because

this was the only material available. It is, therefore, recommended that REGIDESO establish technical standards for electrical materials that are appropriate to the economic and physical conditions of the country and that these norms be followed by all donors that finance projects in the electricity subsector. To simplify future operations, the different types of cables and transformers to be used must be standardized and the number kept to a minimum.

Future Developments in Power Generation

5.26 The theoretical hydroelectric potential of Burundi has been estimated at 6,000 GWh per year (Lahmeyer International, Etude du développement des ressources hydroélectriques du Burundi, August 1983), but in practice only around 1,500 GWh in about 40 projects could be economically exploited. The most attractive national projects are located in two distinct regions of the country: (i) the north-west region where the Gitenge-Kagunuzi and the Kaburantwa rivers are important tributaries on the east side of the Ruzizi river and have an estimated potential of about 100 MW, and (ii) the southern region where the Mulembwe, Jiji, Ruzibazi and Miyovozi rivers have a potential of about 24 MW. Other possibilities that must be exploited in cooperation with other countries are found on the Ruzizi river (Zaire and Rwanda) and on the Ruvubu-Kagera rivers (Rusumo Falls with Tanzania, Rwanda and Uganda). A feasibility study for the Rusumo Falls project was completed in 1987 under the sponsorship of OBK and, in principle, an agreement has been reached with Rwanda to compensate that country for the flooding of its territory, but the project is not being pursued actively by the interested parties. The feasibility study for Ruzizi III was started in 1989 under the sponsorship of EGL and is expected to be completed in mid-1991.

5.27 Of the existing power plants, Rwegura (18 MW) is located in the north-west region, while Nyemanga (1.4 MW) is in the southern region. There are possibilities of expanding the capacity of Nyemanga to 2.8 MW, but this will have to wait for the expansion of consumption in the southern grid. The characteristics of the principal possible domestic new projects are given in Table 5.6, with their costs per installed unit of capacity and for generation based on average production.

5.28 The table indicates that the most interesting domestic projects are Mule 34, Jiji 03, Kabu 16 and Kabu 23. Since Mule 34 and Jiji 03 are in the southern region, which is not connected to the main interconnected network where the principal consumption centers are located, the costs of constructing the corresponding interconnection transmission lines must be added to these projects. Unfortunately, this information is not available and developments in the southern region have not been integrated in the planning of the system.

5.29 In the north-west region, the development of the Kaburantwa and Kagunuzi rivers can be done independently or jointly. In the first case, four sites can be developed on the Kagunizi river (Masango, Rushiha, Kagu 10 and Kagu 06) using the waters already turbinated in the Rwegura power plant and two sites can be developed in the Kaburantwa river (Kabu 16 and Kabu 23). If both rivers are jointly developed, a big reservoir is created on the Kagunuzi river (the Kagunuzi C project) and would be used to irrigate the Imbo Valley to the south and, at the same time, to produce electric energy. In a next stage, the waters of the Kaburantwa would be derived through a tunnel to the reservoir and used

either for an extension of the Kagunuzi power plant (the Kagunizi D power project) if there were a need for additional water for irrigation, or in an independent power plant (Kagunuzi A) if no more water was needed for irrigation. The joint development of the rivers implies the disappearance of the Kabu 23, Kabu 16, Kagu 10 and Kagu 6 projects and their replacement by Kagunuzi C, plus the siphoning of the Kaburantwa river with the addition of either Kagunuzi A or Kagunuzi D.

Table 5.6: FUTURE HYDROELECTRIC PROJECTS

Project	Installed Capacity (MW)	Average Production (GWh)	Guaranteed Energy (GWh)	Estimated Cost a/ (M US$)	Cost per kW (US$/kW)	Unit cost b/ (US$/kWh)
1. North-West Region						
Masango	8.7	31	29	40.2 c/	4,618	0.169
Rushiha	17.9	75	66	57.8 c/	3,227	0.100
Kabu 23	14.1	73	31	31.0	2,201	0.055
Kabu 16	19.1	129	55	44.9	2,351	0.045
Kagu 10	12.4	65	57	44.9 c/	3,619	0.090
Kagu 6	9.0	48	43	31.0 c/	3,440	0.084
Kagunuzi C	16.5	88	83	173.7	10,525	0.257
Kagunuzi C + Kabu	38.7	264	192	256.2	6,619	0.126
Kagunuzi C + A + Kabu	69.2	343	242	317.6	4,589	0.120
Kagunuzi C + D + Kabu	55.2	292	210	285.6	5,174	0.127
Gatebe	31.0	134	91	123.0	3,968	0.119
2. Southern Region						
Mule 34	7.8	67	42	21.0 d/	2,698	0.041
Jiji 03	7.4	63	29	20.0 d/	2,701	0.041
Ruzibazi	4.0	34	20	18.9 d/	4,722	0.072
Muyovozi	5.2	37	28	25.9 d/	4,976	0.091

Source: EDFI, Power Sector Master Plan.

a/ Includes transmission lines. Prices of January 1, 1988
b/ Calculated with a useful life of 50 years for civil works and 35 years for electromechanical equipment and with a discount rate of 10%. Includes transmission and operating costs.
c/ Excludes the installation of overcapacity that is recommended by Electricité de France International for these plants.
d/ Excludes interconnection with the national grid.

5.30 A comparison between the independent and joint development of the Kaburantwa and Kagunuzi rivers was done in the Electricity Master Plan (Electricité de France International, Plan Directeur National d'Electrification, December 1988). According to this study, with equal conditions of electric service and a discount rate of 10%, the joint development of both rivers has a cost that is 35% higher than the independent development, in the case of limited irrigation (Kagunuzi A), and 50% higher in the case of maximum irrigation (Kagunuzi D).

5.31 The joint development of both rivers has certain additional economic benefits in the irrigation sector. Unfortunately, these benefits have not been quantified in a satisfactory manner and, therefore, cannot be compared to the additional costs in the electric sector. What is more troublesome is that alternative ways to irrigate the Imbo valley have not been studied, so as to determine the least-cost

solution from the irrigation point of view. There are indications that the valley could be irrigated building some small reservoirs, which could be combined or not with another reservoir on the Kagunuzi river that would not require the siphoning of the waters of the Kaburantwa river into the Kagunuzi river. In that case, the Kabu 16 and Kabu 23 hydroelectric project could still be developed. It is, therefore, urgent that the different alternatives to irrigate the Imbo Valley be studied, including an analysis of different volumes for the reservoir of Kagunuzi C.

5.32 The Electricity Master Plan prepared by EDFI studied three development strategies to satisfy the demand for electricity in the interconnected system: (a) the separate development of the Kaburantwa and Kagunuzi rivers, called the Kaburantwa strategy; (b) the joint development of both rivers, called the Kagunuzi strategy, and (c) the development of the Rusumo Falls Project jointly with Tanzania, Rwanda and Uganda. The conclusion of this study is that the least-cost strategy 28/ is the Rusumo Falls alternative, which includes the following order of plants: Rusumo Falls, Kabu 16, Kabu 23, and Rushiha. The strategy has the disadvantage of being based on a multinational project with difficult and cumbersome negotiations still pending, and of increasing the dependence of Burundi on imported sources of electric power. The second best strategy is the separate development of the Kaburantwa and Kagunuzi rivers, with the following order of plants: Kabu 16, Kabu 23, Rushiha, Kagu 10 and Kagu 06.

5.33 While the Master Plan prepared by EDFI contains useful information on the different hydroelectric sites and ranks the different projects with a consistent base, its conclusion about the best development strategy and the next power plant cannot be accepted and should be revised. The principal problem is that the Master Plan only considers three strategies and neglects, among others, further development of the Ruzizi river and the possible interconnection with the southern region to use the attractive hydroelectric power plants located in that area. Since the demand projections of the Master Plan are too optimistic even one year after the report was published (see para. 5.10), the dates given for the operation of the new plants are not valid. A revised Master Plan to determine the best future power plants and their order of priority should be carried out in a more systematic way, using all alternatives (including possible thermal units) as well as realistic demand projections. An internal optimizing model comparing all relevant alternatives should be applied.

5.34 The only domestic project for which a feasibility study has been done is Kagunuzi. Since there are several more attractive sites for a future hydroelectric power plant, it is recommended that other feasibility studies be undertaken as soon as possible, as a basis for the revised Master Plan. The sites that should be studied are Kabu 16, Kabu 23, Mule 34, Jiji 06 and Rushiha. As indicated in para. 5.28, the first four are the least cost sites available in the country (based on existing information). Rushiha presents the advantage of being a project that is incorporated in the Kaburantwa and Kagunuzi strategies, while having moderate unit costs. These feasibility studies, together with those of Kagunuzi, Ruzizi III and Rusumo Falls, should be used to determine the order of future power plant development. As was indicated in para. 5.15, a new plant is required to be operational around 1997/98, so there is an urgent

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28/ *The study bases its evaluation of the alternatives on a comparison of present values of investment and O&M costs.*

need to undertake the studies as soon as possible and update and complete the Master Plan so that a judicious decision be made on the next power plant. Terms of Reference for these studies are presented in Annex 5.11.

Operations and Maintenance

5.35 The comparison between production and consumption in 1989 (117.3 GWh versus 93.8 GWh) indicates that total losses in the electricity system of REGIDESO are of an order of 20%. The comparable figure for 1988 was 15.6% which means a substantial increase in the amount of losses. The figures include the consumption of the auxiliary services and the resistances in the power plants that are necessary to avoid cavitation in the machines. If these uses are excluded, total losses were 18.7% in 1989 and 13.9% in 1988. These figures indicate that measures to improve performance and reduce losses are required.

5.36 Losses in transmission lines and their associated transformers were of the order of 3.7% of net production in 1989, which is somewhat on the high side given the small network of REGIDESO. This is especially the case for the 35 kV line Mugere - Bujumbura (Ozone), where losses are calculated at 5.2% of net production. Losses at the distribution level are high (15.6% of the energy supplied in 1989 and 12.5% in 1988), which is explained in part by the old age of the lines in Bujumbura and Gitega. These are in urgent need of rehabilitation. While there are no data to distinguish between technical and non-technical losses, there are indications that the latter are also significant, due to observed deficiencies in meters, in metering and in billing. An intensive program of revising the electric meters in Bujumbura that is in progress at the beginning of 1990, has found deficiencies in about 20% of them. It is recommmended that REGIDESO continue to revise all meters in its system and adopt strict measures of control to avoid billing mistakes and theft of electricity, and thereby reduce its non-technical losses. At the same time, the rehabilitation of the distribution systems of Bujumbura and Gitega should be undertaken as soon as possible, and other measures to reduce technical losses should be identified.

5.37 The number of incidents that interrupt the electric service is quite high. For example, in the month of March 1989, there were five recorded interruptions at the level of high/medium voltage and 27 incidents in the low-voltage distribution system of Bujumbura. In October 1989 there were eight and 25 incidents, respectively. While some of these incidents are due to natural causes that cannot be avoided, the quality of maintenance of the electric network is, in general, low. The personnel in charge of maintenance lacks adequate training, the stocks of spare parts and materials (especially in the interior of the country) are not adequate and there are deficiencies in the logistical support necessary for effective maintenance (communications and transport). The planning of maintenance is too general and, with the exception of Rwegura, there are no detailed programs of preventive maintenance for the power plants, sub-stations and high/medium voltage transmission lines. It is recommended that a consultant be engaged to draw up detailed preventive maintenance plans for the electric system of REGIDESO.

5.38 The operation of the principal hydroelectric power plants (Rwegura, Mugere, Nyemanga) is satisfactory, but service started in these plants quite recently. At Rwegura, which have been in operation since 1986, a mission from the builder (Voith) examined the turbines in February 1989,

changed the profile of the buckets to eliminate the cavitation that had been observed and established a detailed program of control. After 5,000 working hours, the results indicate that cavitation disappeared in two turbines, but remained in the third one. The electro-mechanical equipment will be revised by the builder (Schorch) in 1990. The personnel that was initially trained for the maintenance of the plant has left and the new personnel needs training. Mugere was built in 1982 with the cooperation of the Republic of China, using a very special technology. A group of Chinese experts has remained to assist in the operation and maintenance of the power plant and its associated transmission, and their performance has been satisfactory. The only observed problem has been the load-shedding of the plant when Rwegura loses power. Nyemanga started its operations in 1988 and no problems have been observed, except for the possibility of cavitation.

5.39 However, almost all the older hydroelectric power plants of REGIDESO and DGHER that supply isolated center have experienced operational difficulties. Giheta (1983), Ruyigi (1982) and Buhiga (1984) were not in operation at the end of 1989. Ruvyironza (1980-84) has had problems in all its turbines (Ossberger) and one of them was sent back to Germany for reparation in June 1989. It is not known when it will be returned or if the same procedure will be needed for the others. Because of this, REGIDESO had to install a new diesel group of 705 KVA in Gitega and to lease a group of 350 KVA previously installed in Bururi to the BRAGITA brewery. It should also be noted that telecommunications between Ruvyironza and the power sub-station in Gitega has never worked and that a defect in the grounding of the transmission line has been detected. Marangara (1986) has experienced several problems due to deficiencies in lubrication, regulation and electronic equipment and was out of service several times in 1989. Its total production in 1988 was 677.2 MWH, but 60.0% was consumed in the resistances that are necessary to avoid cavitation. A partial revision of all the equipment of the plant is programmed for 1990.

5.40 Isolated centers that are supplied exclusively from thermal power plants have electric service only during some hours of the day. This is due to the high cost of operation and the low level of revenues. In some places (Rutana, Cankuzo), provincial authorities pay for the fuel and have even received foreign assistance for this purpose (FED). The state of these thermal groups is unknown, but routine maintenance is not done at all or is deficient. Whenever there is a failure, the community is left without service for extended periods of time, and repairs are done on the basis of political pressures. Since most of these centers should be under the responsibility of the DGHER, it is recommended that this institution undertakes a detailed survey of the situation of thermal plants in rural centers and incorporates appropriate criteria in future plans for rural electrification as a basis for decisions regarding installation, operation and maintenance of diesel units in isolated centers.

5.41 While the supply of electricity in the system of REGIDESO comes mostly from hydroelectric power plants, some thermal capacity should be maintained as a reserve for security purposes and for possible back-up in critical situations. The thermal power plant in Bujumbura has a nominal capacity of 7.4 MW, but is able only to provide about 3 MW. To accomplish the indicated purpose it should be maintained and run periodically. A similar situation will apply in Gitega after completion of the 110 KV interconnection line, where some thermal capacity should also be left as reserve.

Electricity Tariffs

5.42 Electricity tariffs in effect up to April 1990 were approved by a decree of the Minister of Commerce and Industry dated March 29, 1989. For low-voltage users, there was only a constant energy charge of BUF15.0/kWh (US$0.094 per kWh). Medium-voltage users had a fixed charge for subscribed capacity of BUF6,000/kW per year (US$37.50 per kW per year) and an energy charge that varies with the hours of utilization:

(a) BUF13.0/kWh (US$0.081 per kWh) for the first 150 hours of utilization of the subscribed power;

(b) BUF12.0/kWh (US$0.075 per kWh) for a utilization between 150 and 450 hours; and

(c) BUF9.0 BUF/kWh (US$0.056 per kWh) for energy above that.

5.43 It must be noted that the charge for a utilization between 150 and 450 hours was not in the original decree of March 29, 1989, and was only established in August 1989. Before that, all utilization in excess of 150 hours had a rate of BUF9.0 per kWh. The decree of March 29, 1989 replaced tariffs that existed since March 1, 1988. In general, during the last years there have been periodic adjustments of electricity tariffs in Burundi.

5.44 Studies of the long-run marginal cost of electricity and the reform of the tariff structure were done in April 1985 and December 1988, but they lacked appropriate depth of analysis and its recommendations were never implemented by the Government. A more detailed and complete study was done by an independent consultant in December 1989 and based on it, the Government decided to implement in April 1990 a comprehensive electric tariff reform. Medium-voltage electric rates were immediately adjusted to the estimated long-run marginal cost (LRMC) values, while for low-voltage users, the adjustment is phased with an initial increase of 27% for all consumption above 375 kWh per month. A social tariff for consumers that use less than 75 kWh per month has also been established. The tariff reform also eliminated the system of free electricity to high Government officials and the personnel of REGIDESO. A table presenting the electricity rates before and after April 1990 and the long-run marginal costs is given below. A summary of the calculations of the LRMC is given in Annex 5.5.

Table 5.7: ACTUAL POWER RATES VS. LONG-RUN MARGINAL COSTS

	Prior to April 1990	April 1990	LRMC
1. Medium voltage			
Power (BUF/kW/year)	6,000	7,525	7,525
Energy (BUF/kWh)			
0 - 150 hours	13.0	18.7	18.7
150 - 450 hours	12.0	12.0	12.0
More than 450 hours	9.0	6.3	6.3
2. Low voltage: (BUF/kWh)			
Social tariff	15.0	12.0	-
General tariff			
0 - 750 kWh/bi-monthly	15.0	16.0	22.5
More than 750 kWh/bi-monthly	15.0	19.0	22.5

Source: Ordonnances Ministerielles 750/080 and 750/126 and F. Lecaros, Etude de Restructuration des Tarifs d'Electricite; December 1989.

5.45 As shown in the study by the consultant, the major part of long-run marginal costs are associated with peak demand. The LRMCs presented in the above table were calculated allocating some of the power costs to energy costs using certain reasonable assumptions and respecting the existing rate structure. Other reasonable assumptions could also have been made to distribute these power costs. In particular, to give more appropriate signals to medium-voltage users, a tariff differentiated by hours of the day could be established. However, at the present time, the required types of meters are not available in Burundi. It is recommended that REGIDESO make these types of meters available to large industrial users and that a tariff differentiating between peak hours (8:00 a.m. to 1:00 p.m. and 6:00 p.m. and 8:00 p.m. during working days) and non-peak hours be established.

5.46 The social tariff has the objective of allowing low-income groups a minimum consumption of electricity at a subsidized price. For these users, the alternative of installing a load control type of equipment instead of a regular meter has been considered. However, with the availability of low-cost meters from South-East Asian countries, the difference in cost is not significant and the meters have the advantage of being more effective and efficient than the load control equipment. Since the social tariff was established only for users that consume less than 75 kWh per month, the target group that receives the subsidy is well identified. There are about 3,600 consumers in this group (approximately 30% of the total), but they represent only about 1.6% of total consumption (or 7.4% of residential consumption).

5.47 The consultant's study also calculated the LRMC of public lighting in Bujumbura and other centers. The values at low voltage levels are BUF105 per watt per year in Bujumbura, and 137 BUF per watt per year in other centers. Since the municipalities have recently been given financial autonomy, the Government should require that they pay the cost of providing public lighting to their communities on the basis of these rates.

Rural Electrification

5.48 As indicated before, the DGHER of the Ministère du Développement Rural (MDR) is responsible for rural electrification in Burundi. This institution has developed several micro-hydro power plants (see Annex 5.4) and built transmission and distribution lines to provide services to some rural

centers. The lack of trained personnel in the DGHER and the small size of the plants and their dispersion explains why these actions have not been very successful. The operation of the plants is always precarious and interruptions of services and extended repairs are common. Administration, billing and collection are inefficient. Improvements in management operations and maintenance of the DGHER electric system is therefore urgently needed.

5.49 On the other hand, REGIDESO has gone beyond the main urban centers defined in the decree of March 11, 1986 and extended its lines to about 17 rural centers not within its area of responsibility (at the same time, DGHER supplies electricity to three centers that are included in the area of responsibility of REGIDESO). At present, of the country's 115 "communes" or municipalities, 32 have their main village electrified, while 83 completely lack electricity service. The Ministère de l'Energie et des Mines has recently completed a catalogue of these villages, with a preliminary indication of the potential market and possible source of electric energy, but no comprehensive plan for rural electrification exists.

5.50 Apparently the DGHER has abandoned the policy of building expensive new micro-hydro power plants and the approach is now to connect new rural lines to the network of REGIDESO. Since the distances are relatively small and there is excess energy in the network, this decision could make sense in economic terms. However, the price to be paid to REGIDESO has not been agreed upon and the responsibilities for the administration, operation and maintenance of the new rural systems has not been defined. DGHER has demonstrated its lacking administrative capacity and most of the rural centers are not financially attractive to REGIDESO, which is struggling to become a profitable commercial enterprise. An alternative would be to make the municipalities responsible for the administration and have them pay REGIDESO for the required technical works, but this possibility requires further analysis of the financial situation of municipalities and assistance to organize the management of the electric system.

5.51 The DGHER has a list of projects that it wishes to undertake in the future (see Annex 5.6). These projects have not been selected on the basis of economic criteria and there are no priorities among them. They have been presented to several donors to elicit their interest. For one of them (line Gatara - Musema - Buraniro) an analysis using existing low-voltage tariffs was done, and the estimated rate of return was low. It is obvious that most rural electrification projects will have financial rates of return below 10%, but they may at the same time have economic rates of return above 10%. Adequate analysis needs to be done to identify these projects. The technicians of DGHER and REGIDESO are not familiar with the differences between the economic and financial analysis projects nor with the use of such concepts in planning rural electrification projects. A brief description of the methodology that should be used for the economic analysis is presented in Annex 5.7. It is clear, however, that training in economic analysis is needed by the relevant personnel of DGHER, REGIDESO and the Ministère de l'Energie et des Mines.

5.52 Given the situation of rural electrification in Burundi, it is recommended that a Rural Electrification Master Plan be prepared as soon as possible. This Master Plan should deal with the institutional issues of the sector (relations between REGIDESO and DGHER, responsibilities of the

municipalities), as well as develop criteria for the screening of areas and villages to be more closely considered, the economic analysis of projects, and the ranking of potential projects in terms of the economic net present value. For each project, a comparison between extending the transmission lines from the national power grid and developing local sources of energy (diesel generators, microhydro sites) must be made. Terms of reference for this Master Plan are presented in Annex 5.12. While this Master Plan is being prepared, rural electrification projects with economic rates of return of at least 10% could be undertaken, provided the revenues they generate cover operating and equipment replacement costs.

Conversion of Industrial Boilers

5.53 Energie des Grands Lacs (EGL) undertook in 1985-86 a technical study of the efficiency in the use of energy in 45 industries of the region, including 15 in Burundi. To reduce the consumption of fuel oil, the study suggested the possibility of converting to electricity the boilers of BRARUDI (brewery) and BRAGITA (brewery) and to peat the boiler of COTEBU (textile). The study did not include an economic calculation of benefits, but EGL and REGIDESO decided to go ahead with the conversion of the three boilers to electricity so as to reduce the excess supply of electric power in the region and develop a market for the Ruzizi II power plant that was completed in 1989. A contract between REGIDESO and BRARUDI was signed in July, 1988, but has not been implemented due to the objections of the World Bank.

5.54 At the beginning of 1990, the CIF-Bujumbura price of fuel oil was between BUF 38 and 51 per liter depending on the transport route used, which in thermal units is equivalent to between BUF 1.1 and 1.7 per megajoules (MJ). The long-run marginal cost of electricity at the Medium Voltage distribution level is BUF 18.7 per kWh, which is equivalent to BUF 5.2 per MJ. Offered as firm power, the use of electricity is more expensive for the country and the conversion of the boilers does not have economic justification. At the prevailing tariff the conversion would not be attractive to the industrial users and the contract was accepted by BRARUDI only because REGIDESO would pay for the new boiler and guarantee a rate for electricity equivalent to the price paid for fuel oil. On these terms, the energy bill of the user would remain constant while he in reality would be receiving a large subsidy to utilize electricity. The contract with BRARUDI was modified in April 1990 establishing the payment of the general medium voltage power rate for the electricity consumed up to 1996 and the right of the industry to decide after that date which source of energy (electricity or fuel oil) it would use. While the amended contract limits the damage, it still includes a large element of subsidy in the form of payment for the new boiler and a limited preferential power tariff. This new model of contract has not been accepted by BRAGITA or COTEBU.

5.55 Burundi's hydro based system, like other predominantly hydro power systems, has a surplus of irregular power over and above what is producible and saleable as firm power. Offering electricity to industrial boilers on an interruptible basis instead of on a firm basis would have been an option to consider under other circumstances. Due to the managerial problems of REGIDESO described below, however, the option is not advisable. The company does not have the technical capacity to effectively apply the concept and needs a simple electricity tariff structure where the scope for discretionary choices is limited in order to avoid misapplications and abuses.

5.56 Therefore it is recommended that the policy of converting industrial boilers to electricity be abandoned. The Government does not agree with this recommendation. In its letter of July 22, 1991, the Government has indicated that "if the revenues obtained from the sale of electricity under the contractual conditions (that is reduced by the Amortization payments for the boiler) are really higher than the costs paid for the purchase of electricity, we will recommend REGIDESO to proceed with that purchase, except if another market for excess supply is found. In other words, if REGIDESO cannot sell the surplus of electricity to other partner (for example Rwanda) with a more interesting margin, she must try to benefit from the market of BRARUDI, which is already assure" (letter of July 22, 1991). The initiative described in paragraph 5.54 is not economically justified, while the alternative of supplying only interruptible needs a more developed institutional framework. It would be more interesting to stud the conversion of industrial boilers to peat and, if the results are positive, promote this alternative as described in Chapter VI.

Institutional Review of REGIDESO

5.57 REGIDESO is a Government-owned public enterprise created in 1968 to generate, transmit and distribute electricity, to pump, treat and distribute water and to execute and supervise studies and work for new electricity and water facilities. It is controlled by a Board of Directors of 11 members appointed by the President of the Republic. Until mid-1989, board members were appointed on the basis of their official positions in the Government, but this was changed with the new law on public enterprises. At present, appointment is based on individual merit and some of the members are drawn from the private sector. The new Board of Directors plays an active role in supervising the actions of management and in giving instructions, instead of rubber-stamping the decisions, as was the case before.

5.58 The General Manager is responsible for day-to-day operations and is appointed by a decree of the President of the Republic, which also appoints the Technical Manager, the Administrative and Financial Manager and the Commercial Manager. The powers of the General Manager are limited because he does not name his management team. The organization chart of the REGIDESO is presented in Annex 5.8. The Technical Manager supervises the electricity and water operations, the maintenance division and the garage. The Electricity Department is sub-divided into five units: projects and studies, production, distribution in Bujumbura, distribution in other centers, and execution of projects. The Administrative and Financial Manager supervises four units: personnel, accounting, control and purchasing. The Commercial Manager supervises three units: billing, recoveries and relations with clients. Recently the country was divided in four regions, each with a Regional Chief who theoretically reports directly to the General Manager but is ranked below Department Head. It is not clear how this regional structure will work within the overall structure of the institution and if it will improve efficiency.

5.59 The Minister of Finance can appoint two auditors ("Commissaire aux Comptes") to verify the financial statements of the enterprises and check its accounting systems and procedures. These revisions have only been done on some occasions. Independent auditors (Treuarbeit of the Federal Republic of Germany) have audited the financial statements of REGIDESO since 1982. They have regularly non-certified the accounts and indicated their reservations due to various noted deficiencies in internal controls and follow-up. In spite of the technical assistance received by REGIDESO from the

World Bank and the KfW, the problems have not been corrected, and only some marginal improvements have been registered. The reorganization of the accounting structure of REGIDESO, the establishment of adequate controls and improvements in financial management are of the highest priority.

5.60 At the end of 1989, REGIDESO had a total staff of 872 permanent and 1,100 temporary employees. Temporary staff should only be used for the execution of new projects, but in practice a number of them work permanently for the company. The ratio of total electricity and water consumers to permanent staff is 27:1, which is rather low. REGIDESO has accepted to increase this ratio to 50:1 by 1992, which would imply a substantial reduction in the present number of workers. There are no job descriptions for the different categories of personnel, and salary increases are given on the basis of seniority and hierarchy and not on job performance. Personnel management policies need to be reformed to increase efficiency and productivity. A summary of the financial situation of REGIDESO is presented in Annex 5.9.

5.61 In the context of the structural adjustment program, the Government has decided to execute a comprehensive reform plan for REGIDESO. Price-Waterhouse of Canada was hired to undertake a detailed diagnosis study and propose a plan to improve the performance of the enterprise. This study served as a basis for a reform plan that was approved by the Government in June 1989. The main elements of this plan are:

(a) reforms in the management of commercial activities to ensure that all electricity and water sales are correctly billed, that billing is made within 15 days of reading the meters and that payments are made with a minimum delay and arrears reduced to 60 days for the private sector and 90 days for the public sector;

(b) a programme to substantially increase the number of new connections, and rationalize and reduce the costs of connections that must be paid by the consumers, allowing term payments of up to 24 months;

(c) reforms of the accounting system to ensure reliable financial statements and produce adequate information for decision making;

(d) implementation of appropriate systems and procedures of internal control and creation of an Internal Auditing Unit under the direct responsibility of the General Manager;

(e) establishment of new systems for the promotion of personnel and for the payment of incentives and revision of the personnel manual and of salary structures;

(f) reduction in the numbers of permanent personnel and strict control with the hiring of temporary staff;

(g) restructuring of the purchasing unit and reform of the systems of purchases and of managing stocks;

(h) establishment of an Economic and Planning Unit, with responsibility for planning and for preparing economic and financial evaluation of all new projects;

(i) application of strict rules of interruption of services in case of non-payments and application of a system of penalties for re-connections and fraud;

(j) execution of measures to reduce electricity and water losses and implementation of a preventive maintenance program; and

(k) establishment of a master plan for computerization, and creation of a special unit to implement this plan.

5.62 The reform plan was annexed to a contract plan signed by the Government and REGIDESO in July 1989. While REGIDESO committed itself to operate as a commercial enterprise on the basis of standard profitability criteria and to execute the reform plan, the Government indicated that it would establish a tariff policy for electricity and water based on the long-run marginal costs, increase the capital of the enterprise and pay operating subsidies for all investments that do not have adequate financial rates of return, but are economically advantageous. The Government also committed itself to undertake a compensation of cross-debts with REGIDESO and to allow for the one-time absorption of previous foreign exchange losses. A supervision committee (comité de suivi), under the leadership of the Service Chargé des Entreprises Publiques (SCEP), was created to follow-up on the implementation of the reforms.

5.63 However, the execution of the reform plan has had a slow start. A new Board of Directors was named at the end of September 1989, a new connection policy has been implemented with some encouraging results, and there have been improvements in billing and in the management of cash funds, but all the other measures remain to be executed. A group of external experts was hired and started work in March 1990 to help REGIDESO implement the reform plan. It must be noted that the reform plan is the only alternative for rehabilitating REGIDESO so that it can efficiently accomplish its objectives and it should be executed with diligence and swiftness.

Investment Proposals

5.64 Investments in the electric sector have been defined in general by the availability of donors' financing, in most cases without an acceptable economic analysis or even a determination of priorities. The structural adjustment program introduced the notion of a public investment program (PIP), which covers a moving three-year period. For the period 1990-92, the total investment program in the electricity sector is about US$28.6 million. Almost all these investments are constituted by expansions and rehabilitations in the transmission and distribution systems. Given the low level of electrification of the country, in general, these efforts should be continued in the future, although priorities should be given by adequate economic analyses. The economic internal rates of return should be calculated and only those projects with a minimum of 10 percent should be undertaken.

5.65 The results of the energy balances (see paragraphs 5.14 and 5.15) indicate that no new investments in expanding the generating capacity of the interconnected system are needed before 1998. The next hydroelectric power generating plant should be determined from a new least-cost expansion program, preferably after completion of the feasibility studies indicated in para 5.34 and construction should start around 1993. The 110 kV transmission line between Bujumbura and Gitega is under execution with financing from KFW -Germany and constitutes the major investment in the next years. The Electricity Master Plan elaborated by Electricité de France concludes that the reinforcement of the 110 kV transmission line between Bubanza and Bujumbura is urgently needed. While in general the conclusions of the Master Plan are not valid due to overly optimistic demand projections and to the analysis of only a few generating alternatives, the reinforcement of this line is justified because it transports at the present time about 65% of the energy consumed in the interconnected system and is crucial to the reliability of the system. If the line fails, between 30% and 40% of the energy demand cannot be supplied by alternative transmission lines. The costs of the failure will increase when the interconnection with Gitega is completed.

5.66 A list of projects to expand the transmission and distribution system is presented in Annexes 5.10 and 5.6. However, none of these projects has been subject to an economic analysis and the corresponding rates of return are unknown. These studies should be completed before deciding upon their execution. The Government has accepted the principle that all new investments in electricity should have a minimum economic rate of return of 10% and this rule should be followed by all donors in deciding future financing.

Recommendations

5.67 The principal recommendations for the electricity sub-sector are the following:

(a) Investments and Planning

(i) expansion of connections in areas where electric service is available should be given high priority. The cost of connections should be reduced through the import of low-cost equipment and materials. REGIDESO should organize a special unit to efficiently plan and execute new connections;

(ii) the rehabilitation of the distribution systems of Bujumbura and Gitega should be undertaken by REGIDESO as soon as possible;

(iii) feasibility studies for the Kabu 16, Kabu 23, Rushiha, Mule 34 and Jiji 03 should also be undertaken as soon as possible and be used for an up-date of the Power Sector Master Plan;

(iv) commitment to the construction of new power plants should be deferred until the feasibility studies indicated in (iii) are completed and a new and well-focused master Plan for the expansion of electricity production has been prepared; 29/

29/ *The Government has indicated that this recommendation "should be qualified", and suggested to wait until the on-going complementary study is completed.*

(v) the multi-purpose KAGUNUZI project should not be executed. A study to analyze the different alternatives to irrigate the Imbo Valley should be undertaken as soon as possible. The next power generating project to be developed should be determined on the basis of least-cost criteria in the updated Power Sector Master Plan, where Kagunuzi should be one of the alternatives to be considered;

(vi) a comprehensive Master Plan for rural electrification should be prepared as soon as possible by the DGHER. This plan should deal with the institutional issues of the sector (roles of DGHER, REGIDESO and municipalities, responsibilities for operations, maintenance and administration, etc.), as well as give criteria for the selection and economic analysis of projects, and rank projects in terms of their economic net present value; and

(vii) the initiative of converting industrial boilers to electricity should be abandoned.

(b) Operations

(i) detailed preventive maintenance programs for each of the power plants, substations and high/medium voltage transmission lines of REGIDESO should be elaborated;

(ii) the personnel responsible for maintenance should be given additional training and the planning and control of maintenance should be improved;

(iii) measures to reduce technical losses should be identified and put in place by REGIDESO;

(iv) for security reasons REGIDESO should keep the thermal plants in Bujumbura and Gitega in operating conditions at all times; and

(v) a detailed survey of the state of diesel units in isolated centers must be undertaken by DGHER and criteria for the installation, operation and maintenance of these units must be defined.

(c) Pricing Issues

(i) the level and structure of electricity tariffs must reflect marginal cost pricing principles in order to eliminate economic distortions in investments and consumption decisions and unwarranted subsidies to some consumers. This means that the initial restructuring of the tariffs already undertaken should be followed up and completed;

(ii) time-of-day electric meters should be offered to large industrial users and medium-voltage consumers, and differentiation between peak and off-peak hours should be established; and

(iii) a tariff for public lighting that reflect the long-run marginal cost should be established and municipalities should be required to pay for this service.

l) Institutional Issues

(i) the implementation of the reform plan of REGIDESO should be accelerated with the active participation of the group of experts hired to assist in the implementation should be hired as soon as possible;

(ii) a capability for economic analysis and physical planning of the generation, transmission and distribution should be established in the REGIDESO as soon as possible;

(iii) following improved planning and training for operational maintenance, consideration should be given to reducing the staff involved in maintenance,

(iv) REGIDESO should continue the revision of all electric meters and adopt strict measures of control to avoid billing mistakes and thefts and, therefore, reduce non-technical losses; and

(v) REGIDESO should prepare technical norms and standards for electrical works and the Government should encourage the creation of an appropriate treatment plant for wood posts.

VI. PEAT

Background

6.1 Despite the fact that exploitable peat resources in Burundi are large, that the capability for exploiting these resources has existed in the country for over a decade, and that peat as a fuel has proved its ability to compete with petroleum products and electricity in a number of countries, it has never received proper attention in Burundi as an indigenous energy resource to be developed on a broad scale. One of the pre-conditions for this to take place is that the industrial sector starts using it. Although peat in any event would continue to play a modest role in the national energy balance, its impact on the balance of payment as a substitute for imported petroleum products could be significant if industry gave it serious consideration.

6.2 ONATOUR (Office Nationale de la Tourbe), the parastatal peat company, was founded in 1977 to handle peat extraction at a level of 200,000 MT per year, mainly in conjunction with a World Bank nickel exploration project. Since this project never materialized, ONATOUR started looking for other users of peat and these were found in the army, other institutions, and among bakeries. Peat sales increased over the years and stabilized some two to three years ago at approximately 1000 MT per month, of which 80% is consumed by the army.

6.3 The main development since the previous energy assessment is that ONATOUR has matured as an organization, has shown its ability to function with minimal technical assistance and financing, and has gradually captured a certain market. ONATOUR received technical assistance for marketing and institutional development from USAID for about 8 years but this ended in 1988 because the focus of USAID's program changed. The Irish Government, through the Irish Peat Board, Board na Mona, provided ONATOUR during the same period with technical assistance for exploration of peat bogs and has pledged to continue this assistance through 1990. CIDA (Canadian International Development Agency) through the company Cartier-MONENCO currently provides technical assistance with research on carbonized peat briquettes. These three agencies worked in close cooperation with ONATOUR and, to a lesser extent, with each other.

6.4 The energy policy guidelines issued by the DGE propose that peat use should be promoted in all sectors of the economy. This includes the conversion of selected industries to peat use instead of wood and/or fuel oil, and the development of peat dust briquettes. 30/ The policy calls specifically for a more active promotion of peat use in the household sector, as well as the dissemination of peat stoves. The earlier recommendation to start a pilot program to test peat use in industries through installing a peat fired boiler was dropped on technical and financial grounds. Technological progress

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30/ *Recently, however, the energy supply to the brewery, BRARUDI, was reassessed and it was decided to install a dual fuel, electricity and fuel oil, boiler instead of the present fuel oil-only boiler, without taking into account a conversion to peat.*

made during the last few years as well as experience gained in other countries indicate that this decision should be reconsidered.

Resources and Production

6.5 Peat is an indigenous source of energy which is non-renewable but available in large quantities in Burundi in highland and lowland bogs. Highland bogs are easier to exploit and do not seem to pose significant environmental problems. Currently, most of the production takes place from the highland bogs; approximately 74% of the highland bog area (170 ha) is under exploitation. Highland resources are situated from 50 to 125 km south of Bujumbura and contain approximately 870,000 MT of peat, mainly in small (40 to 160 ha) bogs nested amongst hills in depressions (see Table 6.1 and the map in the back of the report showing bog locations). Peat production in 1989 was 13,000 MT.

Table 6.1: PROVEN RESERVES a/
(1,000 MT)

	1984	1989
Highland bogs		
Gitanga	570	550
Gishubi	170	131
Kuruyanga	210	173
Kashiru	10	0
Nyacijaima (Ijenda)	15	15
subtotal	975	869
Lowland bogs		
Nyamuswaga	2,300	2,300
Akanyaru		
- Byonyoe b/	20,000	19,998
- Ndurumi c/	14,400	14,400
- Nyavyamo	17,600	17,600
subtotal	54,300	54,298
Total	55,275	55,167

a/ At 30% mcwb (moisture content wet basis)
b/ Only about 250,000 MT or about 1% can be extracted as highland peat.
c/ Densely populated area, highly cultivated, no current peat activities.

Source: ONATOUR.

6.6 According to Bord na Mona, a sustained peat production ("sod peat") from highland bogs is possible at a level of 20-25,000 MT annually for more than 40 years. MONENCO claims that the level of production could be increased to some 50,000 MT per year without expansion into lowland peat bogs. The limiting factor to such an increase as indicated by Bord na Mona is labor-related rather than bog or equipment related. ONATOUR offers wages for unskilled labor at the bogs at the official minimum rate, which is generally applied for all activities in rural areas (forestry projects, agricultural projects, etc.). The company experiences problems attracting sufficient number of laborers during parts of the exploitation season. At present, ONATOUR has all the equipment and spare parts to increase the production of peat by 50%.

6.7 Exploitation of lowland bogs is markedly different than highland exploitation: suction dredges need to be employed to extract peat from the bogs, whereafter it has to (air) dry and be excavated like highland peat. It is clear that lowland peat bogs can only economically be exploited on a large scale and therefore when there is a large demand for peat. The more than 50 million MT of recoverable lowland peat resources are situated 135-160 km north of Bujumbura in large bogs with peat depths of 20-30 meters. Extracting peat from these bogs may give rise to environmental problems (see chapter on environment) and therefore has to be carefully be studied before exploitation. Although lowland peat resources are many times larger than highland resources, they provide less than 10% (1,300 MT in 1989) of total present production and this quantity comes from the approximately 250,000 MT of highland peat available within the lowland bog, mainly in Buyongwe. The magnitude of the combined high and lowland resources is indicated by the fact that they are sufficient for more than a hundred years' production, even if the present rate of exploitation were to increase forty-fold. The total bog surface combined covers approximately 13,000 ha, or less than 0.5% of Burundi's total land area.

6.8 Table 6.2 shows that peat production normally has been higher, in some years significantly so, than peat consumption. This partly reflects the fact that a certain amount of peat is transformed into dust during transport and handling, normally some 10%. In addition, the difference between production and sales in certain years is the result of poor planning, although improvements have been made lately. The current production is organized such that excavation takes place in bogs as close as possible to the major clients. An earlier practice which has almost been abandoned was to transport all peat to Bujumbura where it was weighed before being delivered to the user.

Table 6.2: ANNUAL PEAT PRODUCTION AND CONSUMPTION
(Metric Tons)

Year	77	78	79	80	81	82	83	84	85	86	87	88	89
Kashiru	42	1301	1759	2079	1893	1513	2234	1518	711				
Kuruyange			944	944	1155	5262	4891	3559	2305	3411	5212	4396	4553
Gishubi				511	3387	4124	6168	5734	3184	4760	4786	2642	4033
Gitanga								3254	2713	3879	7532	4161	4312
Buyongwe								1348	1540		890	1314	
Production	42	1301	2703	3534	6435	10899	13293	14065	10261	13590	17530	12089	14212
Sales	42	1301	2703	3534	5570	6072	7852	7634	8237	12203	12000	12000	12500

Source: ONATOUR.

6.9 Environmental degradation could well result from large-scale production, particularly if future exploitation were to take place in new, lowland bogs (see chapter on environment for more details). At the moment, there is no real evidence that actual highland bog exploitation causes environmental problems. On the contrary, the only bog which has been put back in cultivation after its peat reserves were exhausted (Kashiru in 1985), showed higher agricultural productivity than other agricultural land in the surroundings. The drainage system which was put in place for reasons of peat exploitation turned out to be superior to the system created by the rural development programs.

6.10 The lowland bogs on the other hand are mainly located in the densely populated areas of the north and may be subject to negative environmental impacts if put into active use because of drainage problems.

An impact study has never been done and it is strongly recommended to do so before lowland bogs are developed.

Organizational Aspects

6.11 Organizationally, ONATOUR is part of the MEM (the Ministère de l'Energie et des Mines) and comes under the Director of MEM, like REGIDESO. ONATOUR is the only organization working on peat in Burundi. ONATOUR's activities relate to peat (excavation, transport, marketing, public relations, peat stoves/ovens), charcoal (transport, marketing, public relations, improved stoves), and research (peat briquettes production, marketing). The organization supervises its peat operations out of its headquarters in Bujumbura, although bog managers live at the bog sites to supervise daily operations during the production season. Subdivisions in Bujumbura include production, marketing, accounting, technical assistance (to users), and an improved stoves unit (see chapter on household energy). Present foreign aid consists of technical assistance provided by the Irish Government on exploitation practices during the production season. Further assistance is provided by the Canadian Government on carbonization and compacting of peat briquettes.

6.12 ONATOUR's organization was restructured a few years ago, but total peat sales are still relatively low compared to the capacity of the organization and hence, to its overhead costs. However, the accounts of ONATOUR showed a financial profit in 1989 for the first time. To achieve this, one of its two Bujumbura offices was closed, redundant personnel was relocated, management staff was reduced, and various measures to increase the efficiency of its services were implemented. Also, users were supplied with peat from the bog closest to their location instead of via the Bujumbura storage facility, and trucks try to take payloads to the bog site. Presently, ONATOUR is attempting to diversify its operations towards other solid fuels and to increase the market for peat and peat derived products.

6.13 There is no doubt that ONATOUR can handle an increase in peat production up to 20-25,000 MT per year. It has the managerial capacity, staff, and the necessary equipment and peat resources to do so. It would need technical assistance to carry out a feasibility study for the conversion of industrial boilers to peat since any substantial increase in volume can only take place in the industrial sector. An increase of production beyond 25,000 MT per year would most likely require capital investments in new equipment. At the moment, however, sales are only at 50% of this level. For production levels substantially higher than 25,000 MT per year, lowland bogs would need to be developed. Since operations on such a scale are entirely different from those of highland exploitation detailed technical, environmental and financial studies would be necessary.

Costs and Prices

6.14 Extraction costs vary from bog to bog, but typically range from BUF 1.3 /kg to BUF 2.4/kg. The efficiency of ONATOUR's operations were improved a few years ago and average extraction costs are now approximately BUF 2.0/kg. Transport costs depend on the distance from the bog to the client and to Bujumbura. During the last few years, ONATOUR has taken steps to improve the efficiency also of peat transportation.

6.15 Table 6.3 below shows the cost structure for the present rate of production and the retail price of peat, both in Bujumbura and in areas close to the bogs. A hypothetical case is added, with a higher production level, assuming an expanded market at a lower price.

Table 6.3: COST STRUCTURE OF PEAT, 1989
(BUF 1,000/MT)

Exploitation level (1,000 MT/year) c/	12 a/	20 b/
Extraction costs	2.0	2.0
Transport to Bujumbura	3.0	2.7
Overheads	2.0	0.9
Profit margin	1.0	0.8
Sales price in Bujumbura	8.0	6.4 d/
Sales price close to the bogs e/	5.52	

a/ Actual situation
b/ Projected higher sales level
c/ Based on: Transport 10% more efficient; overheads will increase marginally (10%) compared to existing situation; total margin will increase by 33%.
d/ Sales price assumed to be lower in order to increase the market.
e/ Equals extraction costs, overhead, profit margin, plus BUF 0.5/kg in transport costs from bog to user.

Source: ONATOUR, mission.

6.16 Despite its present low level of utilization and therefore its relatively high cost, peat as a fuel is competitive in terms of price with all fossil fuels and electricity: per MJ peat at present costs roughly 30% of fuel oil and 10-25% of electricity (see Table 6.4). These differences could become more pronounced in favor of peat if peat consumption increased and unit costs went down. Industries are reluctant, however, to start using peat as a fuel for various reasons. First, most industries prefer electricity as a clean fuel which is easy to handle, and because a surplus is expected for the next few years. Second, there is little knowledge locally about reliable peat furnaces and boilers and a proper technical/financial feasibility study has not been carried out. A preliminary analysis carried out by the mission shows, however, that the prospects for conversion from fuel oil to peat use are promising (see Annex 6.1), with a financial internal rate of return of around 40% and a pay-back time of less than 3 years.

6.17 In financial terms, the present cost per MJ of peat is comparable to that of charcoal. It is difficult to compare peat to fuel wood because in practice there is no common price for wood but based on observed prices near Bujumbura peat is much more expensive than wood: per unit of energy, it is four to five times more costly than fuel wood. It is under the present circumstances not possible to induce consumers to replace either wood or charcoal with peat: wood is financially much more attractive, and charcoal is more convenient to use (lower ash content, its availability/supply is well known) while it costs the same. Even if the cost of peat were reduced, due to larger production, it would not automatically be adopted by potential users because of its associated inconveniences, such as higher ash content and lower calorific value.

Table 6.4: FINANCIAL AND ECONOMIC COST COMPARISON OF FUELS, 1983

Type of Fuel	----- Financial ----- Cost/unit	Cost/MJ	------ Economic ----- Cost/unit	Cost/MJ
Fuelwood (BUF/kg) a/	2.1	0.13	3.4	0.21
Charcoal (BUF/kg) a/	17	0.55	27	0.84
Fuel oil (BUF/l) a/	69	2.0	63	1.81
Electricity MV (BUF/kWh) a/ b/	18.7-6.3	5.2-1.8	18.7-6.3	5.2-1.8
Peat (BUF/kg) c/	8.0	0.57		
Peat (BUF/kg) d/	6.4	0.46		

a/ For assumptions: see footnotes to Table 3.5 in Chapter III.
b/ For medium voltage (MV) electricity users there is a fixed charge of BUF 7,525/kW/year in addition to the energy charge as shown that varies with the hours of utilization.
c/ Current situation: sales equal 12,000 MT/year. Economic costs are not available.
d/ Possible future situation: sales equal 20,000 MT/year.

Source: DRS, mission.

Uses and Market Potential

6.18 To compensate for the inconvenience in using peat (smoke, smell, ashes; see Annex 6.2) and its cost disadvantage relative to fuelwood, ONATOUR provides customer services aiming at solving potential problems with users' peat stoves and furnaces, and delivers peat at the doorstep of most of the current users. The market for peat can be divided into three distinct segments: the household market, the institutional market, and the industrial market.

6.19 Peat may be used in the (urban) household sector for cooking and it would thereby replace either charcoal or wood. Present household consumption is insignificant mainly because peat needs to be processed into an improved form before households can accept it: without special (expensive) stoves, peat cannot easily be used. Peat in a refined form (carbonized, densified) may be an option worth considering since in this form most of the inconveniences are removed. However, the production process is too costly for this so-called charpeat to compete financially with woodfuels, as was shown in a study by MONENCO. Carbonizing and briquetting of peat was evaluated by USAID in 1987 who concluded that it would not be financially viable for ONATOUR to start producing carbonized peat briquettes. It is therefore recommended that no major effort is launched at this stage to promote peat use in households but that work continues aiming at improving its quality in use and reducing costs.

6.20 In the institutional sector peat is used for cooking (army, prisons, schools) or for process heat (in cottage industries, bakeries, brick and tile factories). Depending on the institution, peat replaces wood or charcoal. Special furnaces, ovens, stoves etc. need to be installed but these can be built at a relatively reasonable cost with local materials with which ONATOUR has considerable experience over the last 8 years. Since the major part of the present peat consumption is in this sector, it is estimated that 4000 TOE/annum of wood is saved, an equivalent of 2% of the 1988 commercial woodfuel consumption. A limited potential for expanding the market exists if price can be reduced.

6.21 In the industrial sector, peat can substitute for fuel oil or electricity. Fluidized-bed boilers or furnaces which combust peat efficiently would need to be installed. Industries which could be considered for such conversion are large industries, such as the textile factory (COTEBU), the brewery (BRARUDI), the bottle factory (VERRUNDI), smaller industries such as tea factories, milk bottling factories, and bakeries, or a new power plant. Potential annual savings could amount to 1,500-2,000 MT of fuel oil for each of the large industries converted to peat use. This would require some 9000 MT of peat per year for COTEBU or BARUNDI, or the other factories together and pave the way for a reduction in unit production costs of peat. The preliminary analysis in Annex 6.1 indicates that such a conversion could be financially very attractive. A phased approach is recommended for a conversion program by focussing on smaller industries to begin with, for technical, organizational and environmental reasons. A feasibility study and field testing of a boiler system is envisaged (see para 6.24).

6.22 In theory, conversion looks quite promising while in practice it will depend largely on technical performance of selected equipment and costs, plus ONATOUR's ability to gear up for the required higher peat production. Recent experience with this type of peat furnaces/boilers in other countries (Ireland, Finland, and the Soviet Union) has shown reliable operations and sound economic investments. In certain smaller industries in Europe, peat used as a substitute fuel in small peat boilers on add-on furnaces has gained popularity.

6.23 It is therefore recommended to carry out a project, the objectives of which are to

(a) determine the technical, financial and economic feasibility of converting selected industries to boilers using peat;

(b) test a boiler system in an industry; and

(c) establish the total viable market for boilers of this type.

An outline of the project with a budget of some US$265,000 and estimated to take ten months is given in Annex 6.3.

6.24 ONATOUR has lately been unable to increase total consumption which would enable a reduction in sales price and could attract new users. Reasons for this failure include the inability to convince potential industrial users and a lack of clear support from the MME, despite indications of financial and technical feasibility. One large industrial client or several smaller ones would be sufficient to realize economies of scale and reduce the sales price. Therefore, ONATOUR should actively pursue industrial usage of peat by taking an initiative to carry out a study as indicated above, while continuing to promote peat use in the other market segments. The study should form the basis for discussions and decisions involving industry, ONATOUR, the Government and financial institutions.

ecommendations

25 Based on the abundance of peat in Burundi, its proven ability to replace (on a limited ale) other sources of energy (woodfuels) in the country, and its potential for cost-effective substitution imported petroleum products and electricity demonstrated elsewhere, the following recommendations e made:

(a) a study of the feasibility of converting boilers to peat use in a selected industry plus a field test should be carried out. Depending on the outcome of the study and the test, the investment should be made and the experience gained should form the basis for decisions whether or not to proceed with conversion in other industries. This would also give ONATOUR time to adjust its operations to a higher level of exploitaiton and to attain a level of operations that could lead to a reduction in the price of peat that could pave the way for an expansion of the institutional market.

(b) promotion of peat use in the institutional sector through, inter alia, enhanced service level to customers, should be continued based on competitiveness of peat with other fuels. On the other hand, peat use in the household sector should not be promoted except that work by ONATOUR to improve the quality of peat in forms that may make it acceptable to this category of clients both with respect to use and price should be continued on a limited scale.

(c) any decisions to expand production of peat by making use of lowland bogs should be preceded by environmental impact studies. In the meantime, the exploitation of peat from the highland bogs should be monitored on a regular basis, by involvement of the relevant department in the Ministère de l'Aménagement, du Tourisme, et de l'Environnement, as new bog areas are being developed and old are being put into agricultural use.

VII. NEW AND RENEWABLE ENERGY OPTIONS

Organization

7.1 A focus on new and renewable energy technologies would seem warranted from the point of view of the national objectives for the energy sector which aim, inter alia, at the development and use of national energy resources and a reduction of the dependence on foreign sources. Such technologies have had limited applications in Burundi, however, despite an environment of quite good resource endowment for certain alternatives and relatively high conventional energy cost. The two major reasons for this situation appear to be, first, the fact that most new and renewable options are non-economic at present-day technologies and international or national energy prices and, second, that efforts have been dispersed over a wide range of technologies, focusing on research development and pilot projects.

7.2 The main institutions involved in the renewable energy sector are found within the MEM, i.e., the DGE, the DRS, and CEBEA, and within the Ministère du Développement Rural et de l'Artisanat (MDRA), the Direction Générale de l'Hydraulique et de l'Energie Rurale (DGHER). In principle, DGE is responsible for all activities in the renewable energy field but in practice DGHER has a role in the promotion of such alternatives. Coordination between DGE and DGHER is insufficient, however, which sometimes results in the latter taking decisions on implementation of renewable energy projects without consulting DGE. DRS is responsible for monitoring all renewable energy systems but has delegated the follow-up of activities in certain areas, like wind and solar energy, to other institutions. In 1989, GTZ started assisting DGE with energy planning under the so-called Programme Spéciale Energie, and a full time advisor to the Directeur Général was appointed. A regional focus as well as a technology focus is being applied: regional in the sense that priority areas have been identified (high population density, dry zones, etc.); technologies selected include biogas, photovoltaics, and improved woodstove designs. As mentioned in Chapter II and III, a firming up of the overall responsibility for household and new and renewable energy technologies is recommended, by giving the DRS an overall planning and monitoring role for these areas.

Solar Energy

Background

7.3 Burundi is relatively well endowed with solar radiation, with an average horizontal influx of 4.9 kWh/m2 per day, or 1.8 MWh/m2 per year, as measured in Bujumbura during the period 1960-1975. Solar energy data have been collected in a few spots in Burundi during that period of time and variations in radiation of 20% were shown, mainly due to differences in altitude, season, and dust. Currently, climatic conditions (including insolation and solar radiation) are monitored in most of the provinces but no systematic effort is undertaken to assemble these data into a common database.

7.4 Since the previous energy assessment additional solar installations have been installed on a pilot basis but not as commercially viable alternatives to other sources of energy. CEBEA was created in 1982 with a mandate for applied research and a focus on solar and wind energy, and the CRAES (Centre Régional Africain pour l'Energie Solaire) was established in 1989 to improve the commercialization and R&D of solar energy technologies as well as to provide assistance to its 23 member countries.

7.5 In general, solar energy applications are presently not economically viable in Burundi although a few limited applications could possibly be feasible. In 1990, new data were collected, to take stock of existing installations and their condition, but did not cover their economic performance. Instead, the focus has been on research, partly without economic relevance. There appears to be no real interest in solar energy among potential users because a number of applications which could be economically viable are quite heavily taxed, and no initiatives have been taken to reduce the taxes.

Uses and Availability

7.6 Applications of solar energy currently found in Burundi include solar water heating, photovoltaic (PV) systems, and crop dryers. There is no local commercial production of any of these technologies.

7.7 Solar water heaters. A few solar water heaters have been installed in health centers, mainly through donor financed demonstration projects. Because of high ambient temperatures, hot water appears in general to be of a low priority in Burundi. In Bujumbura, the potential consisting of higher income households and some commercial establishments (restaurants, hotels, etc.), is greatly reduced due to the fact that many of the higher income households are renting their houses and have no incentive to make the associated investments. A worksheet which is attached as Annex 7.1 shows the prospects of solar water heaters with payback times between 4 and 5 years, if equipment costs are rated at an approximate world average of US$500 per m2 of collector surface and using the current low voltage tariff. In conclusion, there are possibilities of promoting solar water heaters, if locally produced with certain imported elements, but the total market will be limited.

7.8 Photovoltaic systems can be purchased at two locations in Bujumbura at approximately 3-4 times average international prices but data are not available on the total number of systems sold. A system with two 36 Watt panels and three 13 Watt lamps, switches, battery and voltage regulator is sold for almost FBU 500,000 (approximately US$3,000). At this price, there is not a real market for PV systems among private households. The reasons for these high prices are high transport costs, taxes and duties (import (15%), statistical (4%), and luxury (15%)), and large distributor margins. There appears to be a small market niche where PV nevertheless can play a role: PV powered lighting and TV sets for communal and educational use. At international market prices, however, the picture is different and PV systems seem to be able to compete with rural electrification from the grid in certain cases. In Kenya, for example, 50W PV systems are sold commercially at US$600 which would give a price of electricity of US$1.30 - 1.50, including in-house wiring and lamps, etc., over the lifetime of the equipment. A preliminary study of rural electification in certain areas in Burundi gave a cost of US$1.10/kwh excluding

in-house wiring, etc. This implies that PV systems should be considered as an alternative when planning extensions in rural areas (see Annex 7.2 for preliminary costs and comparison of the systems.

7.9 The current total installed capacity of photovoltaic systems is estimated at 45 kW, of which roughly 40% is used for lighting, 40% for water pumping, and the remainder mainly for refrigeration and to provide power for running TV sets. Recent activities include the introduction of portable electric lamps (rechargeable through a PV system) which are meant to be used in households and farms.

7.10 According to CEBEA, less than 10 solar crop dryers are in operation in villages and cooperatives. The time needed to dry crops can be reduced substantially and in practice total crop losses have been reduced by 50%. Economic comparisons have not been made, however, and the systems in use are subsidized in the sense that a large part of the equipment costs are paid for by donors and not by the users. PSE/DGE and DGHER are updating the data on solar energy.

Recommendations

7.11 The potential use of PV systems is limited because of the high equipment costs and this determines the recommendations. It should be left to the private sector to try to expand the market for PV applications to the extent that this is commercially justifiable. Government intervention should be limited to data collection, reducing regulatory barriers, and prioritizing donor financed PV projects, while keeping public financial and manpower resource involvement to a minimum. All work on applications without economic justification (such as portable PV lighting in animal farms, solar distillation) should be abandonned. The following recommendations are made:

(a) the MEM, through DRS and with some external technical assistance, should briefly review present PV applications in Burundi and determine, based on economic evaluations, a priority list of a limited number of PV applications for public services (communications, rural hospitals, dispensaries, etc.); and

(b) the Government should review the regulatory framework related to the import and taxation of PV systems and solar water heaters, with a view to reducing unjustified fiscal and other barriers and facilitating the diffusion of technologies for economic applications.

(c) when planning rural electrification programs, alternatives such as PV systems should be investigated before embarking on grid extension.

Biogas Digesters

Background

7.12 Although biogas digesters will contribute only marginally to the total energy supply in Burundi, energy benefits together with other gains, in terms of environment, agriculture, and health, appear to justify further development. The main activities should, however, be in the hands of the private sector and Government involvement should mainly be limited to promotion and sensibilization.

7.13 Much attention has been given to the production and use of biogas digesters: some 140 plants ranging from 10-150 m3 have been built over the last few years. According to DRS, more than 3/4 of these plants are still in use. Moreover, the majority of these plants have been almost entirely financed by the user. Three projects have promoted digesters: Projet MEM-GTZ (Germany), Projet Sino-Burundais (China), and Projet Méthane (Belgium). Since the end of 1990, the MEM/GTZ project is trying to promote biogas in close collaboration with a private firm. MEM-GTZ has constructed the largest number of digesters (of the smaller type), and in general, these plants are technically somewhat better designed than plants of the two other projects. Table 7.1 gives an overview of the number of digester constructed and in operation.

Table 7.1: BIOGAS PROJECTS

Project	Number of Plants Constructed	In Operation %
MEM-GTZ	57	92
Sino-Burundais	46	87
Projet Methane	10	40
EGL a/	18	44
Private	8	38
Total	139	77

a/ No new construction is taking place.

Source: DRS.

7.14 The Government policy with respect to biogas falls within the wider objective of promoting alternative sources of energy, and activities have been oriented towards the construction of new plants and maintenance of existing ones. The work program of the current projects is heavily supported by the DGE and DRS, and with the recent inception of a new GTZ technical assistance project, a better focus in terms of technology and geographical location of the different projects is being accomplished.

7.15 For the dissemination of biogas digesters to become effective it is essential that sufficient infrastructure for the construction, maintenance and repair of digesters is in place. So far, these services

have been provided by the technical assistance projects but assistance on this form should be phased out. Instead these services should be provided by the private sector. This is likely to be more cost effective as well as quicker in terms of response time, and would be a demonstration of financial/economic viability. The Government's involvement should mainly be in sensibilization and monitoring: creating awareness about the possibilities for digesters, ensuring that the target groups know about the technology, and evaluating energy requirements, savings as well as other benefits.

7.16 In addition to technical support, it is important that a system of financing exists. There is such a system wereby COOPEC finances the aquisition of equipment and construction. The MEM-GTZ Project currently makes use of this partial financing mechanism. Another possibility which is being considered by the different projects is a subsidy towards the high construction costs. This approach is not recommended, unless there are high environmental benefits in potentially risky areas, and then only after a detailed evaluation.

Family Size Digester

7.17 The benefits for the user are: (a) reduced need to buy or collect woodfuels for cooking and buying kerosene for lighting (for a family of seven this could amount to 2.5 MT of wood and more than 100 litres of kerosene per year); (b) faster and more convenient cooking and better lighting; (c) improved hygienic standards and lower risk of diseases due to the collection system for animal and human waste; and (d) output of a high quality fertilizer. A quantification of the benefits is currently being made by the MEM-GTZ Project.

7.18 The MEM-GTZ Project has constructed some 60 digesters which in most cases have been fully paid for by the user. There is a subsidy element in the form of technical assistance for maintenance visits, and the owners may borrow 50% of the capital cost which is repaid over 2 years. The two main constraints with respect to a wider ownership of digesters are the initial cost and the availability of animals. Minimum requirements are at least four head of cattle which must stay in the neighborhood of the digester and preferably in a stable or an enclosure at night. Only a small percentage of households in Burundi owns four or more cattle so the potential for biogas digesters will be limited. Secondly, a digester costs BUF 100-150,000 which precludes most families in a country where the daily wage in rural areas is BUF 150. The cost of cement has increased significantly during the last few years and accounts for more than 60% of the total costs of material. MEM-GTZ have concluded that as a result of the increase, there is little interest in constructing new plants despite the financing scheme.

7.19 It is recommended that ongoing research activities to reduce construction costs be accelerated (prefabricated digester parts, standardized parts), and that possibilities of making the financing scheme more operational be investigated through the initiative of the MEM. Future activities regarding biogas digesters should be oriented towards a decentralization in favor of villages with high demand and with maximum participation of the private sector and the focus of DGE/DRS should be on promotion and sensibilization of potential owners.

Institutional and Commercial Enterprise Digesters

7.20 There are 125 boarding schools in Burundi (many of which with more than 600 students), and many of these have inefficient cooking stoves and insufficient latrine systems. The BPE (Bureau des Projets d'Education) has decided to construct digesters instead of latrines in all new schools and in schools to be rehabilitated. In addition to improving the hygienic situation and using the slurry from the digester to increase agricultural productivity, biogas is produced covering around 10% or more of the energy demands of the schools. There is a need, however, to upgrade the maintenance service provided to the schools for the systems and to educate the staff of the schools in the functioning and use of them.

7.21 Only a few commercial enterprises have installed biogas digestors (one chicken farm, a few dairy farms) for heating, lighting and cooking purposes. In addition, the existing systems are not used to their full potential. As an example, a farm of 250 cows could save annually more than 10m3 of kerosene while at present the actual figure is only 20% of this quantity. There may be several reasons for this: irregular supply of waste, lack of maintenance and therefore failing operations, lack of awareness of the benefits, or uneconomical operations. Before any further investments are made, the causes of the low degree of acceptance and utilization should be determined, and on that basis decisions should be made to halt, maintain or further promote the installation and use of biogdigestors in institutions and commercial enterprises. The GTZ technical assistance program would have a natural role here.

Recommendations

7.22 The Government should limit its involvement and rely on the private sector to install, service and maintain new biogas systems as a result of the benefits that users perceive and the decisions the latter make with respect to installing bio-digesters. The following recommendations are made:

(a) assistance to construct and maintain biogas systems should be transferred to the private sector and carried out on a commercial basis. The DGE should assist in strengthening the servicing function and identify the modalities for transferring this to private firms. Government involvement through the DGE should be limited to identifying opportunities for diffusion of the technology, promotion and making target groups aware of the benefits offered by digesters;

(b) furthermore, the Government should accelerate the research work aiming at reducing construction costs, and assist through the MEM in setting up a suitable financing arrangement through a local bank for users that fulfill the requirements for viable installation and use of digesters; and

(c) experience with institutional and commercial enterprise biogas digesters should be reviewed as a basis for deciding whether or not to continue installing them and if so how to improve their operations, based on technical, environmental and economic

considerations. It is recommended that the GTZ technical assistance program support the Government in carrying out the above mentioned recommendations.

Briquettes

7.23 Briquetting of agricultural residues is in principle an environmentally sound practice: the residues are normally wasted or burnt on the spot, and they replace woodfuels that may come from fragile resources. Briquettes of the correct consistency could have equal fuel qualities as wood or charcoal, and acceptance is mainly determined by customs and culture, and by financial considerations.

7.24 Burundi has had at least three ongoing efforts to promote briquettes. A private entrepreneur currently sold "bio-coal" which is made from carbonized coffee husks and/or rice husks which are densified into pellets with a low pressure compactor and using a binder (cassava flour). The sales price (BUF 28/kg) was close to that of charcoal, and the burning characteristics were also quite similar. Coffee husks were currently obtained free of charge from the coffee factory in Bujumbura. Alternative uses of these husks, apart from being burnt on the spot, are insignificant. The entrepreneur stopped production because revenues did not cover operating costs.

7.25 The second effort to promote briquettes is by ONATOUR which tries to sell carbonized peat dust. Peat dust is a waste product resulting from the transport of peat from the bog to the central storage in Bujumbura. Approximately 10%-15% of the transported peat is transformed into peat dust, amounting to 2,000 MT in 1989. Peat is carbonized first and densified later into briquettes with a low pressure compactor (with a binder). The first trial (1988) was based on 100% peat dust but the reaction of the households was not overly positive: the burning characteristics were not as good as those of charcoal. The second trial used a mixture of charcoal dust and peat dust which got a better reception. Future research will also look at mixtures of coffee husks, rice husks, etc., together with peat dust.

7.26 A third project is being executed by CEBEA, and is co-financed by the Belgian Government and FED. 31/ This effort would be research oriented: the optimal mix of feedstock for briquettes would be determined, utilizing waste material available in the surroundings of the capital: coffee husks, rice husks, wood waste, etc. A new hangar has already been constructed, but the final confirmation to buy the densification equipment has not been given by the donor.

7.27 The supply of coffee husks is limited and seasonal, yet all three projects intend to use this as their main (or a substantial) feedstock. The private entrepreneur has already found the supply of coffee husks to be too limited for year-round production. Alternative feedstock exist, like rice husks and wood chips, but these are not available right in town. The supply of peat dust is not subject to seasonal or availability limitations at the level of production that is envisaged at present.

31/ *Project "Action thématique Bois de Feu".*

Recommendations

7.28 It is recommended that efforts to promote briquettes as a substitution fuel be discontinued, in view of the large availability of cheap charcoal and limited supply of agricultural residues. The recent experience of the bio-coal firm supports this recommendation.

Wind Energy

7.29 Statistical data collected between 1960-1975 show that in general, Burundi has a wind climate which is not very interesting from the energy point of view. New wind energy data have not systematically been collected in recent years and there is no evidence that windmills can be used on a large scale. However, sufficient windspeeds prevail at certain specific sites such as the Imbo Plain during the period from 12 noon to 6 pm when the average wind speed is around 5 m/s. A few windmills have been installed here to pump drinking water for surrounding villages, and appear to be performing reasonably well. These systems are constructed under demonstration projects to which the beneficiaries have made no financial contribution. Whether wind energy under these conditions makes sense in economic terms is uncertain. Alternatives such as PV powered waterpumps and extension of the electricity grid need also to be taken into account when considering such systems.

7.30 Given the limited potential and limited Government resources, it is recommended that windmills continue to have low priority. The involvement of the DGE should be limited to monitoring existing windmill installations and evaluating their technical and economic performance against that of alternatives such as grid extension, diesel systems, and PV systems.

VIII. ENVIRONMENTAL ASPECTS

Background

8.1 Certain environmental issues have been a source of concern for several decades in Burundi, particularly soil degradation and deforestation. This concern is due to the specific nature of the country and the relation between high population growth and limited natural resources. The Burundian Government has played an active role and from early on had a perception of its responsibilities in this field: the Département des Forêts has addressed these issues over the last twenty years through active promotion of agroforestry and reforestation. In 1988, a new ministry was created, Ministère de l'Aménagement, du Tourisme, et de l'Environnement (MATE), to oversee matters related to the environment, the activities of which are carried out by five different divisions and institutes: Département des Forêts (DF), Département du Génie Rurale et du Patrimoine Foncier, Département de l'Aménagement du Territoire et du Cadastre, Institut National pour la Conservation de la Nature (INCN), Institut Géographique du Burundi.

8.2 The main characteristics of the environmental situation in Burundi are as follows:

(a) Burundi is the second most densely populated African country with approximately 210 inhabitants per square km (km2) of arable land or 180 per km2 of total land. Population growth is high with an average annual increase of 3%.

(b) Some 90% of the population lives in rural areas and depends largely on agriculture. The vast majority of farmers live on dispersed homesteads and cultivate small plots on hillside land. There is little flat land other than marais (marshlands) and pasture land and the proportion of easily cultivable land is low. This situation is expected to deteriorate as the population continues to grow and also due to a complex land tenure system.

(c) Soil erosion related to the high population density, intensive cultivation, overgrazing, and deforestation is serious in certain regions. Clearing of forested lands for agriculture allegedly takes place albeit prohibited.

(d) More than 80% of the total energy demand is satisfied with woodfuels. Commercial supply of these fuels in urban areas, both as charcoal and as firewood, has resulted in localized deforestation problems; the inefficiency of both charcoal production and energy end-use in stoves only exacerbates this problem.

(e) Less than 4% of the total land area has been set aside (recently) for conservation (national parks) and recreational purposes; inventories of flora and fauna are currently being undertaken.

(f) Present peat extraction on a small scale from highland bogs are not seen to have detrimental effects. If large-scale development of peat deposits were undertaken, this could have a negative impact on the local environment due to potential disturbance of fragile watershed areas and to competition with agriculture for arable land on peat bogs.

8.3 Even though there are quite a number of ongoing activities directly or indirectly related to the environment, a systematic and overall approach to assess and to alleviate (potential) environmental problems does not exist. Furthermore, no institution is responsible for seeing to it that environmental impacts of energy development and projects/programs are systematically taken into account. Experience from other countries has clearly shown the benefits of having an institution that will evaluate all new projects on their environmental soundness, improve donor coordination and lobby for funds to implement environmental measures.

Table 8.1: SUMMARY OF ENVIRONMENTAL ACTIVITIES

Category	Main Actors	Activity
Soil conservation	DF, MATE	Reforestation,
Soil fertility	DF, MATE	Agroforestry, sensibilization
Natural forests	DF	Protection, reforestation
Reforestation	DF	Protection, reforestation
Agroforestry	DF, DGHER	Protection, reforestation
Water resource protection	REGIDESO	Sanitary protection, aqueducts
Lowland development	DGHER	Drainage, irrigation
Energy conservation	DGE, ONATOUR, DGHER	Stoves, renewable energy technologies
Energy resources	DGE, ONATOUR	Peat production
National parks		INCNProtection

Source: DRS, mission.

8.4 Recently, however, the Government has indicated that it is interested in preparing an environmental assessment under a Special Project Preparation Facility (SPPF).
The contents of the SPPF would possibly include:

(a) a general survey of environmental issues to be addressed in a national environmental policy and a certain number of projects;

(b) an analysis of legislative issues to serve as a basis for a legal framework for the protection of the environment; and

(c) recommendations for strengthening the Ministry of Environment.

Relationship Energy-Environment by Energy Source

Wood

8.5 Agricultural expansion is the main source of local deforestation, as a result of present cultivation practices, the growing need for new arable land, and the complex land tenure system. Even though no precise data exist on actual wood resources and their use, observations show that many hillsides have been stripped of their tree cover almost to the summit over the last twenty or thirty years resulting in serious soil erosion and watershed problems. Population growth is indirectly responsible for these problems and unless effective measures are taken in this respect, technical approaches will only yield marginal results. Wood used as a cooking fuel by households in the form of firewood or charcoal puts an additional strain on local resources. Although the extent of depletion of resources and local deforestation is not well known, the situation gives cause for serious concern. Other uses of wood, such as for timber and building poles, do not have any significant impact on the environment because of their minimal use.

8.6 Activities that aim at countering the deforestation and erosion problems are underway: a number of crests have been planted with protection plantations, agroforestry programs encourage the planting of trees on homesteads, and forestry programs promote the planting of trees for energy purposes. So called arborization has gained momentum and currently produces wood for part of rural household cooking fuel needs. However, the need to know much better what is actually happening with respect to forest resources and to step up activities that counter present negative trends require urgently initiatives as described in Chapter III. It is recommended that the ongoing activities aiming at increasing present wood resources are reinforced, as indicated in Chapter III, with an emphasis on expanding the agro-forestry program and being very selective as to establishing new wood plantations.

8.7 Although the main thrust has aimed at the supply of wood, some small-scale activities to reduce wood consumption by rural households have been undertaken or are ongoing. So far, however, the results have not been very encouraging: basically, stove models are too expensive compared to the stoves currently in use which are free, at least in monetary terms. It will therefore, be very difficult to successfully disseminate improved stoves in rural areas and it is recommended instead to focus on sensibilization of the population on environmental issues regarding firewood collection and on the value of wood in general.

8.8 Commercial activities using wood as their main source of energy include institutional canteens, small restaurants, bakeries, brick and tile factories. In 1989, the Government decided to promote the use of metal and tiled roofs. Particularly in the northern areas where high quality clay deposits exist, many small artisanal tile manufacturing industries can be found using wood as their main fuel. These operations have a serious impact on the environment for two reasons: they are very energy inefficient and they increase the demand for commercial wood. It is recommended that woodfuel conservation measures among these types of users are identified and implemented and, furthermore, that wood from industrial plantations which are now reaching maturity is made easily available for purposes like these.

Charcoal

8.9 The overall efficiency of production and consumption of charcoal is such that it constitutes a waste of energy compared with direct utilization of wood. Charcoal is the preferred cooking fuel of urban households, however, and there is little scope for substitution over the medium term. It is therefore necessary to focus on improving the efficiency of both the production and the use of charcoal.

8.10 Unfortunately, the actual situation in terms of sources of wood for charcoal production and the channels through which charcoal passes is not well known, and the environmental impacts ascribable to charcoal production cannot therefore be properly determined. But the problem of deforestation associated with charcoal production in other countries warrants first, an initiative to determine and, thereafter, improve the complete charcoal making - transport - marketing - and utilization cycle. This involves improving the efficiency in the charcoal production process as well as of household cooking devices. Ongoing activities with respect to improved stoves and charcoal production methods should be reoriented and reinforced as described in Chapter III. Furthermore, a strategy for the commercialization of wood from industrial plantaitons should be prepared, since these appear to be relevant sources for charcoal production. Finally, demand management through appropriate pricing of wood and taxation of charcoal as recommended in Chapter III should be part of an integrated approach to achieving energy savings and environmental benefits.

Agricultural Residues

8.11 The extent of agricultural residue utilization for energy purposes is unknown but the mission estimates that total consumption could be 10-20% of household wood use in rural areas. Whether this consumption has negative impacts on the environment is difficult to determine: the prevailing practice is to burn most of the residues in the field, although alternative uses exist for certain residues, like covering the top soil for protection purposes or for soil improvement. As woodfuels become scarce or when there is a temporary abundance of residues (e.g. immediately after harvest), people utilize these residues to a greater extent. The impact on the environment by not leaving the residues in the fields cannot be quantified without further investigation. It is recommended that this quantification be carried out as part of survey of the rural energy needs and resources, proposed in Chapter III.

Peat

8.12 Several aspects of peat development have an impact on the environment: quality of the resources, method of production, utilization of peat, and disposal of wastes, all of which are discussed below.

8.13 Resources. Most of Burundi's peat resources are in lowland areas although only a fraction is in use (see Chapter VI). Lowland peat bogs are usually located in fragile watershed areas which can easily be disturbed. Most of the current peat production, on the other hand, comes from highland resources which are not subject to the same environmental constraints as lowland bogs. Water regulation and drainage problems can be overcome in most cases, however, if properly planned and monitored.

8.14 Production. There is no real evidence that peat production will destroy the soils to the extent that the bogs, once exhausted, cannot be used any more for agriculture. In fact, the only peat bog (Kashiru) in Burundi which has been closed down after extraction of all useful peat subsequently showed increased agricultural productivity. A one-meter layer of top soil was left before all peat excavation operations were discontinued. The artificial drainage system from the peat operations was superior to the one normally put in place in other marsh lands for agricultural purposes. ONATOUR should ensure that these improved drainage systems are in place and function properly when it discontinues production from a bog. It should also ensure that a sufficiently thick layer of top soil is left on the bog to allow agricultural production.

8.15 Utilization. During the utilization of peat, harmful elements may be released. Improper combustion (as with any other fuel) will lead to an increased CO level. Since peat from some of the bogs contains a number of elements (sulphur, chlorine, etc.) which have a negative impact on the environment, (a) specific peat combustion devices should be installed (peat stoves in the institutional sector, peat ovens in the artisanal sector, peat burners or furnaces in the industrial sector, together with scrubbers and cleaners), and (b) ONATOUR should extract peat only from bogs which contain sulphur below a certain limit ($\leq$ 0.5%). In fact, ONATOUR discontinued production from one small bog with high sulphur content peat (> 1%) some years ago. Actual exhaust composition for peat stoves, bakeries, etc. has not been measured but problems have so far not been reported. It is recommended, however, that prior to starting commercial utilization of peat in industries, tests measuring the composition of emissions be conducted as part of the preparations.

8.16 Waste. Ash content of Burundi peat varies greatly (even within a bog) but is generally quite high for solid fuels. An average of 15% can be taken as a reasonable estimate which implies that per MT of fuel, 150 kg of waste needs to be deposited. At present, no alternative uses for the ashes have been identified, nor have ways and means of disposal been studied. It is recommended that the issue of ashes (alternative use, disposal) be incorporated in the feasibility study to be carried out to assess industrial use of peat.

Petroleum Products

8.17 Burundi is not at present an oil producing country nor does it refine oil products. As a landlocked country, the main activities associated with petroleum products are transportation, storage, and product utilization. The environmental aspects of these activities are limited to occasional risks, such as leaks from road accidents, spills in Lake Tanganyika, and storage hazards. No major accident has been reported to date, however. The main risks are obviously in Bujumbura where most of the demand is concentrated. A large storage depot exists in Gitega, and some of the larger industries buy and store large quantities of petroleum products, for which no legislative regulations exist. It is recommended that these legislative issues be addressed and a policy guideline be prepared.

8.18 If and when off-shore drilling takes place in Lake Tanganyika, certain preventive measures need to be implemented to avoid pollution of the lake. It is recommended that provisions addressing such issues be added to any contract for oil exploration and produciton, both in terms of prevention and cleaning up of spills.

Hydropower

8.19 In general, large hydropower investments have significant and usually detrimental impacts on the environment, especialy on acquatic fauna. In the case of Burundi, power is supplied from 27 hydroelectric plants, of which all the largest have been built in the 1980s. Little specific information is available on the environmental impacts of the majority of them or to what extent potential effects were studied at the time of their planning. By and large, such impacts are now assessed and taken into consideration at the feasibility and planning stages. For one of the most recent and by far largest plants (accounting alone for more than 50% of the country's installed hydroelectric capacity), Rwegura, a detailed study was made in 1986 of the risks of waterborne diseases associated with the dam that was to be built, as well as of the possibilities of fish stocking in the reservoir. For both factors, the conclusion was that the risks and opportunities, respectively, were both small and did not warrant specific measures. Other effects of building Rwegura, anticipated at the planning stage and borne out by experience, has been the greater degree of integration of the region due to the access roads and administrative facilities, including schools, that were built, and the reduction in flooding of agricultural land.

8.20 The most recent hydropower scheme, the regional project Ruzizi II, had consequences from some 2,100 persons living in Zaire and Burundi, who received compensation for loss of land, in addition to of fish ladders being constructed. Other ecological consequences for Burundi related to this project are not reported. The only major hydropower scheme on the list of sites under consideration for future development in Burundi for which a feasibility study already exists, is the Kagunuzi Multipurpose Project. The study assesses environmental impacts of the project, in particular the negative consequences of a future dam, and recommends measures to neutralize these, including steps such as reforestation to prevent erosion.

8.21 National and regional power plants will be built in the course of 1990s. Assessments to obtain all relevant information on environmental consequences of hydropower plant construction and operation need to be carried out on a systematic basis. All new major projects should be subjected to sound impact assessment procedures of a quality that is of international standard. Furthermore, environmental effects should be given due consideration among the factors determining the choice between national and regional power projects.

Briquettes

8.22 Briquettes are likely to have a positive impact on the environment as they substitute readily available waste materials for direct use of wood or charcoal: coffee husks, rice husks, and other agricultural or sylvicultural wastes. At present many of these waste sources are generally considered a nuisance and are burnt on the spot. The two main environmental issues related to briquetting are whether or not (a) residues used for making briquettes alternatively would have served as soil improvement; and (b) briquettes replace woodfuels taken from fragile sources.

8.23 Current and planned briquetting activities all work or intend to work with readily available residues which have no alternative uses, as a fuel nor as a means of improving the soil, so from

that point of view there should be no problems. Whether briquettes will replace wood from fragile sources is currently not known. When briquettes are used they will primarily replace charcoal and a reduction in the cutting of wood for charcoal production will quite certainly have environmentally positive consequences. The recommendation in Chapter III to study the charcoal production and marketing cycle is therefore being supported also from this point of view. Based on the outcome of such a study, the size of the potential market for briquettes could be estimated and the full economic feasibility be determined.

Methane - Biogas

8.24 Environmental impacts from using biogas digesters are generally positive as observed by the MEM-GTZ project in a number of existing biogas installations: hygienic improvements due to organic matter management, soil improvement due to the effluent output, replacement of wood as a cooking fuel. Environmental risks are slight and are related to gas explosion and gas leakage into the atmosphere. An evaluation of, among other things, environmental costs and benefits of the said project is underway. If the evaluation is positive (not just on environmental but also on economic grounds), the most suitable target groups should be identified and further promotion of biogas digesters should take place as outlined in Chapter VII.

Relationship Energy-Environment by Region

8.25 The environmental impacts of energy supply and use are specific to certain locations in Burundi. These impacts vary in magnitude according to the geographical location. The main concerns in this respect are:

(a) The balance of wood demand and sustainable growth is likely to be negative for a number of prefectures surrounding Bujumbura as well as in the densely populated areas of the North. Plantations have been established in these areas to satisfy the commercial demand for woodfuel in the future, but wood from these sources are generally not available to the majority of the population, living in rural areas.

(b) Woodfuel demand in the hilly regions has resulted in serious soil erosion problems, particularly in the Mugamba-Bututsi area; protection plantations have been introduced on many of the hill crests to mitigate these problems.

(c) Because population density is directly linked to environmental impacts, the role of Bujumbura is critical. Charcoal demand will continue to increase and the gap between sustainable supply of and demand for wood is likely to widen in areas close to Bujumbura and other cities. As a concentrated energy demand center, Bujumbura is subject to the associated risks, including the possibility of accidents linked with petroleum products storage and distributions.

(d) A potential problem exists related to peat extraction in the northern bogs due to population pressure in the area and the related demand for additional agricultural land.

Conclusions and Recommendations

8.26 The following table presents a summary of possible environmental impacts associated with present and future energy demand/supply in Burundi.

Table 8.2: SUMMARY OF ENVIRONMENTAL IMPACTS OF ENERGY SOURCES DEVELOPMENT IN BURUNDI

Energy Source	Negative Impact	Probability of Occurrence	Positive Impact	Probability of Occurrence
Wood	+++	+++	0	0
Charcoal	+++	+++	0	0
Petroleum products	+	+	0	0
Hydropower	+	+	0	0
Peat	+	+	+	+
Agricultural residues	?	+	0	0
Briquettes	0	0	0	+
Biogas	0	0	+	+

Notes: The more +'s, the higher the impact (whether negative or positive) and the higher the probability of occurrence (without counteractive measures).

Source: Mission estimates.

8.27 As seen in Table 8.2, traditional sources of energy are associated with the greatest environmental impacts as well as the greatest risk of occurrence. For these reasons and due to their economic significance, action should be focussed on the utilization and supply of wood and charcoal. Environmental benefits are related mainly to briquettes and biogas but their significance is limited.

8.28 High population density and rapid population growth will, if unchecked create major ecological imbalances in Burundi. Demographic pressure is translated into environmental consequences, via many channels, including energy needs. The Government is aware of this and has emphasized this issue on several occasions. However, population policy has not been pursued with vigour and reasonable population projections lead to a significant population growth in the future. It is time that the population policy is made effective in order to respond, among other concerns, to the growing energy and environmental problems in Burundi.

8.29 It is recommended that a National Environmental Strategy (NES) be designed which will produce guidelines for increased environmental protection and better management in the future. Among these guidelines, three aspects are of particular relevance to the energy sector:

(a) institutional setup;

(b) environmental protection tools; and

(c) certain energy specific activities.

8.30 The DGE will have to liaise with all institutions which have environmental responsibilities for protection and management of resources and for sensibilization of the population. The need for a specific environment unit should be assessed in relation to the proposed NES. The DF is the natural agency for protection of forest resources and to ensure that woodfuels are supplied in the environmentally most sound way.

8.31 Environmental protection tools include the environmental impact assessment procedure which should be used any time major decisions or investments in the energy sector are to take place: forestry exploitation, hydropower development, increased peat production, briquette production, and biogas development. Other tools include legislative regulations with regards to possible negative impacts on the environment of oil spills, peat production, etc. The Government should identify staff training requirements to enable environmental issues to be adequately addressed in all energy related work.

8.32 Certain specific activities to immediately improve the environmental situation in Burundi include measures to strengthen management practices of wood plantations in relation to commercial wood supply and charcoal production, and certain low-cost programs to promote environmentally sound energy sources and utilization practices.

NOTES TO ENERGY BALANCE

1. The quality of energy data vary enormously and the proforma character of the energy balance needs to be emphasized. For wood and its derivative charcoal, and for other biomass (agricultural residues etc,) there are virtually no statistics since most of these energy carriers move in the informal economy. Figures in the balance are based on the mission's estimates, on the basis of discussions with the authorities, a few surveys of mainly charcoal use in households, etc., as referred to in Annex 3.1. The overall figures for primary wood production, some 2,380,000 MT (household sector estimate 2,330,000 MT plus an estimated 50,000 MT in industry and institutions) is considerably lower than the 3,700,000 MT estimated by the Direction Générale de l'Energie (DGE) for 1985. Underlying the DGE estimate is a figure for consumption per household, 2.1 kg per day, which in the missions opinion is unrealistically high (see Chapter III on household energy). For charcoal, the overall production and consumption are estimated in the same way, by combining number of users with assumed consumption per user. Charcoal consumption in institutions and industry is not accounted for, although it is very unlikely that it should be nil.

2. For electricity, petroleum products and peat, the data on supply and overall consumption are good. Statistics on the breakdown on consumer groups or consumption purposes refer to differently defined categories, however, due to different ways of obtaining these data. Electricity, with individually metered consumers has the most detailed data, while the final destination of petroleum products cannot be so easily traced.

3. Because of these differences in the statistical base, the energy balance refers to consumption categories with a very broad and not very precise definition. Households are taken to include economic activities which with regard to energy use cannot be distinguished from the household proper, such as small scale commercial, artisanal and industrial activity. Industry figures are likely to capture mainly the medium to large scale users. Public services include government, defense, health and education. The breakdown of petroleum project consumption is based on orders of proportion as described in Chapter IV.

INTERNATIONAL COMPARISONS OF COMMERCIAL 1/ ENERGY CONSUMPTION, 1987

	Population (millions) 1/	GNP/Capita (US$)	Energy Consumption (mn kgoe)	(kgoe/cap)	(kgoe/US$ GNP)	(Energy Imports as % of merchandise exports)
Burundi 2/	5.2	240	59	11	0.05	22
Rwanda	6.6	285	106	16	0.06	31
Chad	5.4	160	97	18	0.11	n.a.
Central African Republic	2.7	380	94	35	0.09	14
Niger	6.8	300	240	35	0.12	15
Togo	3.2	370	115	36	0.10	6
Somolia	5.7	170	288	51	0.30	20
Zambia	7.2	290	1,312	182	0.63	6

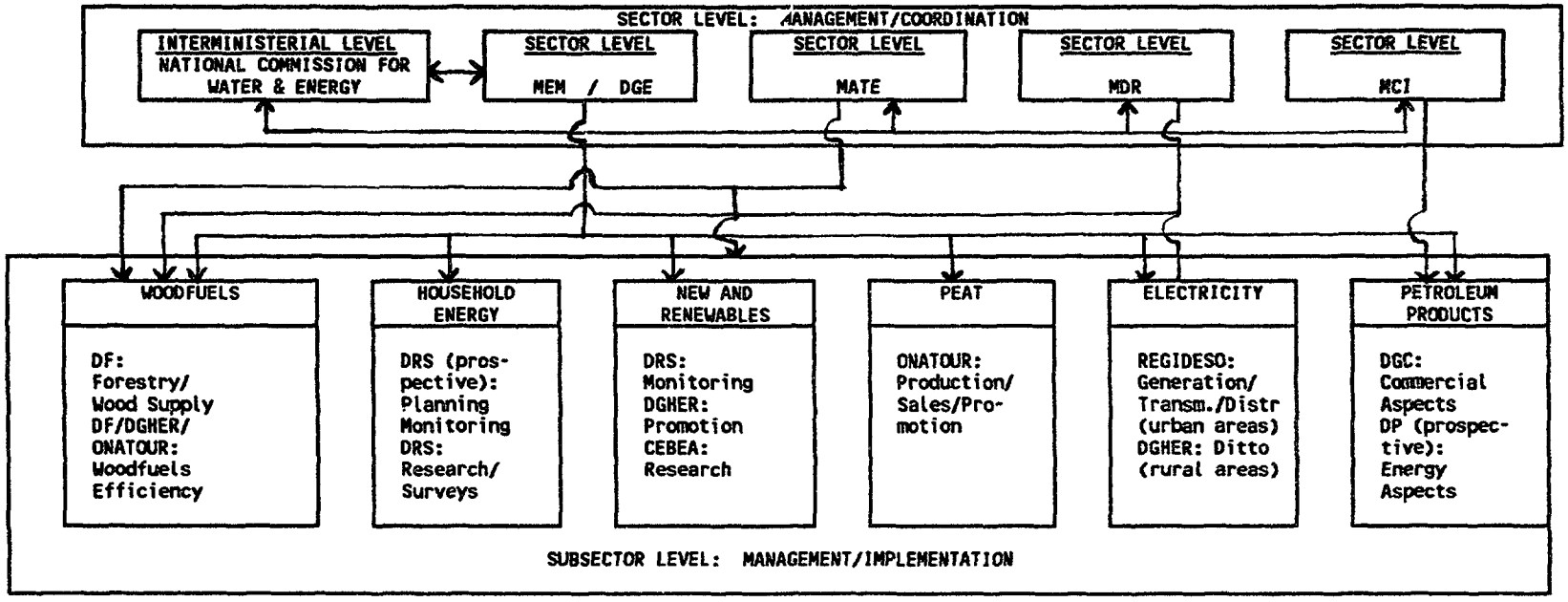
1/ Petroleum products, electricity, natural gas and coal.
2/ 1988

Note: Comparators are countries whose population and per capita GNPs are between approximately 67% and 150% of Burundi's.
"kgoe" = Kilogram oil equivalent.

Source: World Bank: Industry and Energy Department Working Paper: Summary Data sheets of 1987 Power and Commercial Energy Statistics for 100 Developing countries; World Development Report 1990; mission estimates.

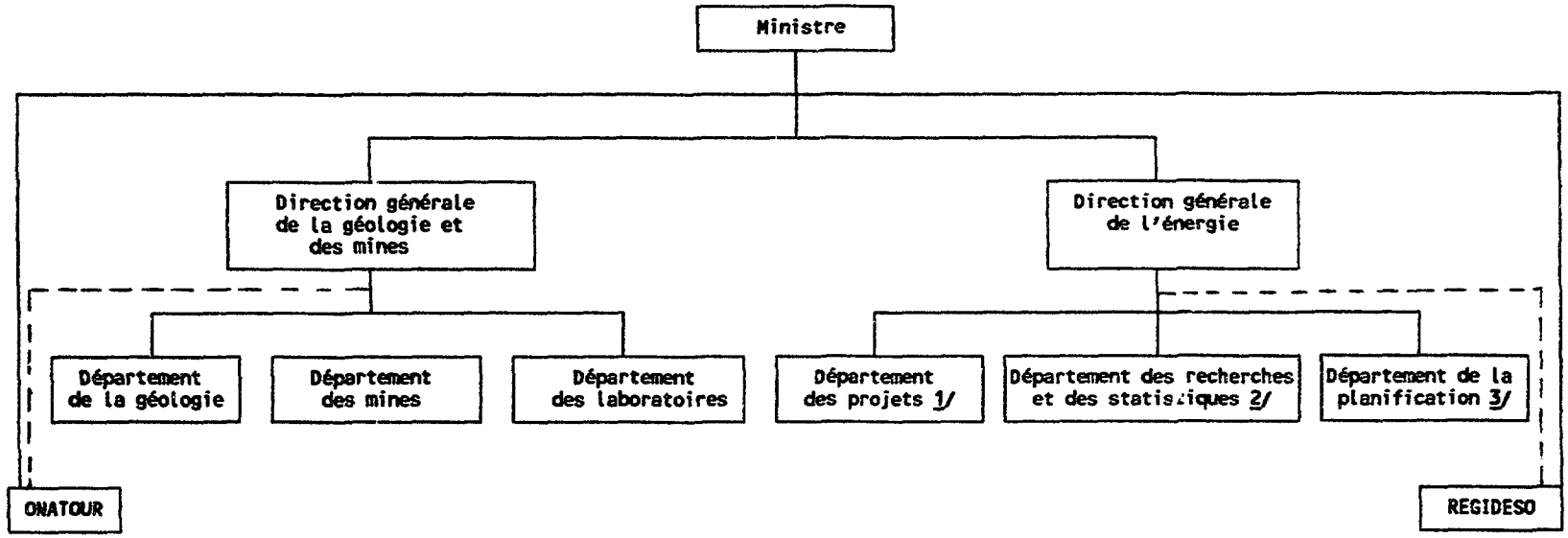
ENERGY SECTOR

SIMPLIFIED FUNCTIONAL ORGANIZATION CHART



MINISTRY OF ENERGY AND MINES

ORGANIZATION CHART



1/ To include a proposed petroleum unit.
2/ To include proposed household energy planning.
3/ New department to be established.

CONSUMPTION OF WOODFUELS AND OTHER BIOMASS

1. A few surveys have been conducted in the past to assess household energy consumption, focussing more on urban than on rural areas. These surveys revealed average per capita consumption figures for charcoal and wood which vary over a wide range (see Table 1 for charcoal). The only significant rural survey dates back to 1984 and was executed by the Département des Recherches et Statistiques (DRS) in a relatively small household sample. A larger sample survey is currently being carried out by DRS but preliminary findings indicate that additional work needs to be done. The 1984 results are not in line with what is observed in most other Sub-Saharan African countries with similar or higher income characteristics: the average daily consumption level was, according to the survey, 2.1 kg of wood per person which is about twice the average for other countries. It also means that a wood using family would consume 43% more energy than a charcoal using family which seems rather unrealistic. An average consumption figure for comparable countries amounts to 1 kg of firewood per person per day. Discussions with DRS resulted in an improved set of estimates of present and future consumption levels of charcoal and wood, based on unit estimates. In the present project the average figure for wood in other countries increased by 25% is taken to reflect the apparently higher consumption level indicated by the previously mentioned survey. Due to the high altitude, cooking would be expected to require more fuel than what is normal elsewhere. The adopted figure of 1.25 kg of wood is close to averages from surveys in neighboring Rwanda. For charcoal, consumption is estimated at approximately 0.40 kg/person/day, the average of the surveys in Table 1.

2. The more clearly characterize the woodfuel situation in Burundi, three regions have been distinguished: Bujumbura, all other urban areas, and rural areas. For the same reason, woodfuels have also been divided into three categories: charcoal, and wood which is purchased or collected. The observed situation in Burundi combined with the lack of reliable data lead to a simplified but in broad terms realistic pattern of woodfuel consumption shown in Table 2. In rural areas firewood is collected by the users themselves and does not enter the commercial channels. In urban areas, woodfuels, in the form of charcoal and firewood, are generally marketed products purchased by the urban dwellers.

3. Consumption of woodfuels by industries and institutions is included among commercial users in Table 2. A survey was done by DRS (1984) in these sectors to determine their demand for wood for energy purposes. It gave as a result a quantity of wood corresponding to approximately 2% of the estimated household woodfuels consumption at that time. As no newer estimates or indications of trends exist, the same figure of 2% is added in the table to give an overall picture of woodfuel consumption in Burundi.

4. The use of agricultural residues is not well documented as no survey has covered this fuel. It is likely that residues are used extensively in rural areas after harvesting of the crops and during the other seasons, depending on their availability. Residues would therefore substitute for wood which otherwise would have been collected. Studies in Rwanda show a use of agricultural residues on an annual basis varying between 10% and 20% of the consumption of biomass in rural areas. In the Burundian context a share of 15% has been estimated.

5. Table 3 shows the projected consumption of biomass fuels of households up to year 2000. The figures for 1988 are taken from Table 2. The forecast assumptions are given in the notes to Table 3.

Table 1: HOUSEHOLD CHARCOAL CONSUMPTION IN BUJUMBURA ACCORDING TO DIFFERENT SURVEYS

Survey	Year of Survey	Number of persons per household	Daily Consumption (kg) per household	person
Ministère des Eaux et des Forêts	?	?	2.0	333
Ministère des Travaux Publics	1986	5.8	2.1	362
Projet DUB 1) /Banque Mondiale	1986	5.9	2.9	492
CURDES 2)	1988	7.3	3.2	436
Average of above for a household of 6 persons	-	6	2.4	406

1) DUB: Développement Urbain de Bujumbura (World Bank Second Urban Project)
2) CURDES: Centre Universitaire de Recherche pour le Développement Economique et Social

Source: DRS, mission.

Table 2: WOODFUEL CONSUMPTION, 1988 (Metric Tons)

		M%
I. Households		
Charcoal		
Bujumbura	33,484	
Other urban	7,591	
Rural	0	
Subtotal	41,075	
Wood for charcoal	410,748	17.2
Wood purchased		
Bujumbura	18,204	
Other urban	84,195	
Rural	0	
Subtotal	102,399	4.3
Wood collected		
Bujumbura	0	
Other urban	0	
Rural	1,822,990	
Subtotal	1,822,990	76.5
Subtotal households		
Purchased	513,147	
Collected	1,822,990	
Subtotal	2,336,137	
II. Industry and institutions (purchased)	46,723	2.0
Total	2,382,860	100

Assumptions: These figures are based on per capita consumption of woodfuels as discussed above. Average consumption figures are 0.41 kg of charcoal/person/day, and 1.25 kg of wood/person/day. For assumptions on population distribution see notes to Table 3.

Source: DRS; mission estimates.

Table 3: PROJECTED HOUSEHOLD BIOMASS CONSUMPTION

	1988	89	90	91	92	93	94	95	96	97	98	99	2000
Population projections (1,000 inhabitants)													
Bujumbura	255	279	293	308	323	339	356	374	393	413	433	455	478
Other urban	256	264	272	280	288	297	306	315	325	334	344	355	365
Rural	4701	4836	4976	5119	5267	5418	5574	5734	5899	6068	6242	6420	6604
Total	5223	5380	5541	5707	5879	6055	6237	6424	6616	6815	7019	7230	7447
Biomass Shares (%)													
Bujumbura													
- Charcoal	85	85	86	86	87	87	88	88	88	89	89	90	90
- Wood	15	15	14	14	13	13	12	12	12	11	11	10	10
of which -- purchased	100	110	100	100	100	100	100	100	100	100	100	100	100
-- collected	0	0	0	0	0	0	0	0	0	0	0	0	0
Other urban													
- Charcoal	20	22	24	27	29	32	35	39	43	47	52	57	63
- Wood	80	78	76	73	71	68	65	61	57	53	48	43	37
of which -- purchased	90	90	91	91	92	92	93	93	94	94	95	95	96
-- collected	10	10	9	9	8	8	7	7	6	6	5	5	4
Rural													
- Charcoal	0	0	0	0	0	0	0	0	0	0	0	0	0
- Wood and ag. residues	100	100	100	100	100	100	100	100	100	100	100	100	100
of which -- purchased wood	0	0	0	0	0	0	0	0	0	0	0	0	0
-- collected wood	85	85	85	85	85	85	85	85	85	85	85	85	85
-- ag. residues	15	15	15	15	15	15	15	15	15	15	15	15	15
Biomass Consumption (MT) 1)													
Bujumbura													
- Charcoal	33,484							48,789					63,841
- Wood of which -- purchased	18,204							20,458					21,266
-- collected	0							0					0
Other Urban													
- Charcoal	7,591							18,194					33,968
- Wood of which -- purchased	84,195							81,796					59,312
collected	0							0					0
Rural													
- Charcoal	0							0					0
- Wood & ag.residues of which													
-- purchased wood	0							0					0
-- collected wood	1,822,990							2,223,766					2,560,970
-- ag. residues	321,704							392,429					451,936

Assumptions:

- In 1988, the population is estimated at 5,2 million people, of which some 10% live in urban areas with 266,000 persons in Bujumbura.

- Increase in population
  - Bujumbura : 5% per year
  - Other urban areas : 3% per year
  - The country as a whole: 3% per year

- Biomass shares
  - The share of charcoal in Bujumbura increases by 0.5 percentage points per year due to households switching from wood to charcoal.
  - In urban areas other than Bujumbura, the share of charcoal increases by 10% per year reflecting the lower base and more rapid switch to a more convenient fuel.
  - The share of purchased wood increases by 0.5 percentage points per year with a corresponding decrease in collected wood.
  - Agricultural residues : 15% of wood use in rural areas

- Woodfuels consumption :
  - Wood: 1.25 kg/person/day, or 7.5 kg/household/day.
  - Charcoal: 0.41 kg/person/day or 2.44 kg/household/day.

Additional Assumptions regarding projections in Table 3.1 on Household Energy Consumption

- Consumption increases:
  - Kerosene : 3% p.a. (population growth)
  - LPG : 5% p.a.
  - Electricity: See demand forecast in Chapter V

- Efficiencies:
  - Wood stove (3 stone open fire) : 12%
  - Traditional charcoal stove (Imbambura) : 22%
  - Charcoal production process : 10% (weight basis, 30% moisture content)

---

1) For the sake of completeness, it should be mentioned that total woodfuel consumption by households as well as by industry/institutions amounts to 2,382,860 MT in 1988, and would increase to 3,055,761 MT in 1995 and 3,692,027 in year 2000. As indicated in the text of the Annex, woodfuels consumption by industry/institutions is taken to be 2% of that of households.

Source: Mission.

WOODS RESOURCES AND PRODUCTION

Table 1: ESTIMATED WOOD PRODUCTION CAPACITY (1988)

	Surface ha	Standing Stock g/ m3/ha	Increment g/ m3/ha/ year	Standing Stock 1000 m3	Increment 1000 m3/yr	Increment 1000 MT/yr	Wood Density h/ MT/m3
Natural Forests	56,700	100	2	5,670	113	79	0.70
Village Forests a/	12,300	60	4	738	49	32	0.65
Forestry Department b/	9,140	150	8	1,371	73	48	0.65
Project Plantations	45,840	225	20	10,314	917	596	0.65
Savannahs	300,000	15	0.5	4,500	150	105	0.70
SRD c/	8,510	80	6	681	51	28	0.55
Private plantations d/	61,000	200	15	12,200	915	595	0.65
Arborisation e/	500,000	5	0.5	2,500	250	163	0.65
Nude f/	278,340	0	0	0	0	0	0.00
Agriculture f/	1,455,900	1	0.06	1,456	87	57	0.65
Urban	55,670	0.5	0.05	28	3	2	0.55
Total	2,783,400			39,458	2,608	1,705	

a/ Plantations less than 10 ha, maintained and owned by villages; they may have been established by the DF.
b/ Plantations larger than 10 ha, established by the DF.
c/ Sociétés Régionales de Développement.
d/ The 1988 consumption of commercial woodfuels amounted to approximately 560,000 MT (see Table 2 in Annex 3.1). This implies an acreage of some 60,000 ha with an average annual sustainable yield of approximately 10 MT/ha.
e/ An average of 2.5 farms or households per hectare with 17 trees per farm is assumed, which results in approximately 5 m3/ha of standing stock. The annual sustainable yield is estimated at 0.5 m3/ha.
f/ Mission estimates.
g/ The standing stock and annual incremental growth figures are based on selected statistics and discussions with officials of the DF.
h/ Density (MT/m3 solid, air dry wood)
- natural wood 0.70
- Eucalyptus 0.65
- Pine, Callitrus 0.50

Source: Mission estimates, DF.

Comments to Table 1:

1. Plantation productivity figures in Burundi vary greatly: plantation performances range from very poor to excellent. One of the project plantations has the highest known yield for plantations in Africa.

2. An indication of the production capacity of Eucalyptus for fuelwood is illustrated by a stand of Eucalyptus trees planted in Gakara, under the World Bank/FAC project from 1982 (8 years old). The density approximates 1300 trees/ha with an average diameter of 40 cm, yielding an average sustainable production of 38 m3 per year (25 MT/year). These results are exceptional, mainly because of the excellent quality soils and prevailing rainfall pattern in combination with the plantation management techniques.

3. Other industrial project plantations have lower mean annual increments which range from 15 to 25 m3. Communal plantations are in general less well maintained resulting in lower annual sustainable production. Average production figures are in the range of 3 - 4 m3/ha/year. The FAC project measured productivity in two sampling areas in Kirimiro (Gitega) and Mosso where all trees and their wood volume were indexed. It showed a standing volume of 4 m3 and 8 m3 per ha, respectively, for village plantations and Government plantations.

FUTURE WOOD RESERVES - AN ILLUSTRATION

1. To illustrate the potentially very serious impacts of the still fairly modest depletion of wood reserves on the supply and stock of wood in Burundi taking into account supply and demand dynamics, the development has been simulated in the table below for the period up to year 2000, using data in Tables 3.1 and 3.2 in the main text. Consumption includes wood use for energy purposes by industries and institutions, in addition to household use, but not for non-energy purposes nor wood cut for land clearing.

2. On a national level, wood consumption for energy purposes exceeds mean annual increment (MAI) by 40% today, which as shown in the table would rise to 150% in 1995 and 600% in year 2000. The stock of trees would decrease to 3/4 and 1/3 of the present level in the two years shown, respectively. The figures illustrate the exponential pattern of development, once depletion starts to occur. The development does not, however, take into account countervailing forces that come into play in situations of more significant scarcity of wood.

Table 1: TREE STOCKS AND DEMAND/SUPPLY OF FUELWOOD
AN ILLUSTRATION

	1988	1995	2000
Growing stocks			
- volume, 10^3m^3	39,458	28,615	12,265
- % 1988 stock	100	73	31
Mean annual increment (MAI), 10^3m^3	2,608	1,889	809
Consumption, 10^3m^3	3,643	4,673	5,645
Excess of consumption Over MAI			
- volume, 10^3m^3	1,034	2,784	4,836
- %	40	147	598

Source: Mission estimates.

3. To test the validity of the results, the growing stocks in 1988 were increased by 20% and the table was recalculated. The aggregate stock of trees in year 2000 would still have been reduced to a level of 60% of the present stock and consumption would exceed MAI by some 200%. This leaves the conclusion of a potentially serious situation of depletion unaltered.

BIOMASS RESOURCE INVENTORY AND DEVELOPMENT OF A WOODFUEL MANAGEMENT INFORMATION SYSTEM

Outline of Study

Development Objectives and Scope

1. The development objective is to assist the Government of Burundi in formulating a strategy and concrete proposals for developing sustainable woodfuel supplies for the country. Integrated management of the woodlands, taking into account wood production and other land use interests, is vital, not only for sustained woodfuel production, but also as an environmental safeguard. To effectively plan and implement such management, information on the nature, area and productivity of the woodlands is essential. Step one will be to prepare a set of detailed maps (1:50,000) to be able to select a stratified sample for the satellite imagery data analysis. Step two will be analysis of the satellite data (spot imagery). Step three is the ground thruthing, step four is designing the management system and the training of counterparts. The Département des Forêts will be the government agency responsible for implementation and will make available two persons for the 8-10 months duration of the activity.

Immediate Objectives

2. The immediate objectives of the inventory are to:

(a) provide information on the area of woodland and bushland by crown density classes in the country;

(b) provide statistically reliable data (standard error +/- 20%) on the volumes and weights of biomass by species and size classes, including branchwood, to 4 cm diameter. The quantity of wood available for poles and sawnwood should also be estimated;

(c) provide indications as to seedling regeneration capability;

(d) establish the basis for continuous monitoring of growth and mortality in the woodlands;

(e) establish a forest resource management information system; and

(f) strengthen the capability of the DF and of the regional forestry offices to carry out continuous field inventory and to compile and analyse the resultant data.

Outputs

1. The principal outputs of the inventory will be:

(a) field corrected overlays for 1:50,000 thematic imagery maps and forest type maps showing woodland and bushland crown density classes;

(b) processed data i.e., statistical tables showing the volume and weight of biomass by species and size classes to 4 cm diameter for each woodland type on a regional and subregional basis, and classified to the type of ownership (Government, village, private). Data will also be provided on the amount of poles and sawnwood available on the same basis;

(c) Regression and volume tables showing the relationship between measurable parameters and the volume and/or weight of woody biomass to utilization limits;

(d) Train field crews in the inventory methods to be used;

(e) Carry out the field inventories with periodic field checks to ensure accuracy of the data collection;

(f) Concurrently carry out destructive sampling of trees of different species and size classes and carry out regression analysis to determine the relationship between the volume and weight of woody biomass (including branches) to the utilizable diameter limit and measurable parameters such as bole diameter, crown diameter an/or total tree height;

(g) Compile and process the inventory data into stand and stocking table for each forest type on a regional and sub-regional basis as is most appropriate;

(h) Concurrent with the biomass field sampling carry out sub-samples to determine the amount of regeneration and the species involved in each forest type;

(i) Compile and analyse the data on regeneration drawing conclusions as to the potential for future natural regeneration;

(j) While carrying out the field sampling decide upon and establish (using permanent markers) a series of permanent sample pilot in each woodland/forest type;

(k) Carry out and record initial sampling in the permanent sample plots including measurements to determine age if possible;

(l) Purchase the necessary computer hardware and software and develop the necessary programs to establish a forest resource management information system. This would include data on the area and quantity of woody biomass in utilization classes for designated areas; data on demand and consumption of wood/forest products for designated areas; and data on wood/forest products' economic and financial prices; and

(m) Before and during the course of the inventory conduct training courses for professional and technical staff on inventory sampling methods and field procedures (both theory and practical); data analysis; and computer programming for inventory data compilation and analysis.

Activities

4. The following activities will be undertaken in close cooperation with the staff of the DF and of the respective regional and district forestry departments. A satelite imagery bureau will be responsible for providing thematic imagery maps with overlays showing the woodlands strata for inventory planning. This bureau will also be responsible for final imagery interpretation and the production of woodland type maps.

(a) Using the results of the field inventory to finalize the interpretation of woodlands strata already delineated on imagery overlays 1:50,000 color maps will be completed and printed. These will be based on the existing 1:50,000 topographic maps series and show, apart from the woodland types the general vegetation/land form and land use types, settlements, infrastructure and principal geographic features;

(b) Establish field sampling procedures including the sampling methods, sampling intensity, the method of locating and marking sample plots and the parameters to be measured;

(c) Plan and organize the field sampling logistics and data compilation;

(d) Information on seedling regeneration capability by forest type;

(e) Established permanent sample plots and initial indications of tree age classes;

(f) Establishment of a computerized forest resource management information system; and

(g) Development of an enhanced inventory capability in the DF and in the regional and district forestry departments.

Budget

5. The budget of the activity is estimated at US$700,000, which includes all costs for local personnel and government staff. Excluded are costs for office space.

	US$	
Equipment		
- cars	40,000	2 cars
- other	15,000	wood cutting equipment, wood sample analysis, etc.
- office	15,000	computer, software, communications
- aircraft	8,000	16 hrs
Map production, overlays	150,000	in foreign country 1/
Satellite data imagery -- " -- analysis	140,000	1/
Ground truthing	20,000	incl. operational costs
Consultants	198,000	12 man-months in the field
National personnel	54,000	2 supervisors and 4 personnel for 8 months
Contingencies	60,000	10%
Grand total	700,000	

1/ Could be executed as part of a package, contracted to a consulting firm.

HOUSEHOLD ENERGY CONSUMPTION SURVEY

Outline of Study

Introduction

1. A reliable household energy data base in terms of available energy resources and actual energy consumption is not available in Burundi. A few surveys have been carried out over the years but these were neither systematic nor representative of the population. The largest survey to date, a consumption/ household budget survey, which is executed under the Bank's Social Dimensions of Adjustment program, started in 1986 and will be finalized this year. Unfortunately it has not included energy consumption, except for a few questions regarding electricity. Because the quality of energy planning depends on the quality and reliability of the underlying database, such information is required.

2. On the resource side, Terms of Reference for an evaluation (with satellite data) of state, village, and private resources have been written and bilateral financing for prompt execution has been requested. This is therefore excluded from the current project. On the consumption side, even though data, for instance, on electricity consumption exist, it has been collected in an isolated context and not in an integrated manner to obtain the households' total energy consumption pattern. Moreover, recent changes in Government policy vis-a-vis benefits in kind for higher level staff (like virtually free housing, electricity) may cause energy consumption patterns to change.

3. The survey should be carried out along the following lines to allow for more accurate classification of household energy use patterns in the country:

(a) in Bujumbura city;

(b) in secondary cities, like Gitega, Ngozi, Rumonge, etc;

(c) rural areas, with the following 5 zones: (i) the high mountain zone; (ii) the northern zone (towards Ngozi); (iii) the plateau (Kumoso, Cankuzo); (iv) the Imbo Plain; and (v) the southern zone.

4. In addition to geographical location, households should be classified according to their purchasing power. Ideally, this would be surveyed through disposable income but in practice it is very difficult to get reliable data. It is therefore better to classify spending power in terms of type of dwelling, like in a villa; house made of bricks, cement, wood, corrugated sheets; rugo, with a house from baked mud with a roof of tiles, corrugated sheets, leaves; apartment; barrack, etc.

5. A total sum of 4300 households, or approximately 0.5% of the total number of households in the country, will be asked to participate in the survey. This number is relatively high, particularly

with the stratified sample outlined above, but this choice is justified in the light of the complexity of the household sector in Burundi and its importance for the overall energy balance of Burundi.

Objectives, Scope of Work

6. The primary objectives of the survey are to collect statistical data per geographical zone and per type of household with respect to:

(a) the level of consumption of: electricity, kerosene, charcoal, wood, agricultural residues, animal dung, solar energy;

(b) the type of end-use per type of energy: cooking, lighting, ironing, house heating, water heating, drying, etc;

(c) the households' attitude towards the different types of energy, and the susceptibility to changing their current habits (e willingness to substitute one fuel for another); and

(d) certain socio-economic household data (size of household, level of education, employment, existing equipment (such as refrigerator, water heater, tv, vehicle, type of stove, number and types of lamps, iron, etc.)).

7. A secondary, but important objective of the activity is to provide training to the Government agency responsible for conducting surveys in order to enable it to update the database on a yearly basis, without external inputs. The survey will be carried out by the Direction de la Recherche et des Statistiques (DRS). A national specialist will be recruited to coordinate the day to day activities including the data collection, input and analyses. A team of ten enumerators will be involved. An external survey specialist will assist the local team at the beginning of the activity to define the questionnaire, and to prepare the data entry, and towards the end of the survey for analyses, etc.

Budget

8. The total budget of the activity is estimated at US$170,000, of which the Government should contribute the countervalue of US$6,000. The survey is expected to take eight months.

	US$
International Consultant	72,000
National personnel	22,000
National specialist	14,000
Equipment	28,000
Local travel	15,000
Operational costs	9,000
Miscellaneous	6,000
Other local costs	4,000
Total	170,000

BURUNDI: HOUSEHOLD ENERGY PROJECTS

Project Name	Start	End	Financing	Government Institution
Methane Gas Project	1982	1990	Belgium	DRS
Biogaz Cankuzo	1984	1990/94	GTZ	DRS
Biogaz project	1983	1990	China	DRS
CEBEA	1982	1989	Belgium	DRS
CRAES Solar Energy	1982	1990	UNDP	DRS
Improved Stoves (component of IBRD Power Transm. and Distr. Proj.)	1986	1990	IBRD	ONATOUR/ MEM
Fuelwood Stove project	1988	1990	China	DRS
Programme Speciale d'Energie (PSE)				
• TA energy planning	1989	1991/93	GTZ	DGE
• Regional planning Gitega	1990	1991/93	"	DGE
• Biogaz	1989	1990	"	DRS
• Charcoal	1990	1990	"	DGE
• Solar energy	1990	1991	"	
DRS/DGHER				
Second Forestry Project	1985	1990	IBRD/FAC	DF
Projet Crete Zaire-Nil (reforest)	n/a	n/a	French Coopr.	DF
Projet Mugamba-Bututsi (reforest)	n/a	n/a	Belgium/ Saudi Arabia	DF
Support to DF (TA and reforest)	n/a	n/a	FED	DF

Source: DF; DGE.

IMPROVED STOVES - FINAL PHASE

Outline of Project

Introduction

1. Charcoal is the primary energy source for 85% or more of the households in Bujumbura. Improved stoves were introduced some 5 years ago, 1/ and more than 15,000 have been sold to date. Surveys showed that households make charcoal savings of approximately 30%, which gives an important reduction of the household budget. Conservative estimates used to identify total economic benefits show a penetrative rate for improved stoves of about 10%, and this coverage should be increased to at least 40% to make the production and sale of improved stoves a self-sufficient activity. In the light of rapidly increasing charcoal consumption in secondary towns promotion of improved stoves should take place there in addition to Bujumbura.

Objectives, Scope of Work

2. The objectives of the project are three-fold:

(a) the reduction of specific charcoal consumption in Bujumbura, and subsequently in other (charcoal using) towns;

(b) the commercialization (on a self-sustaining basis) of the production, distribution, and sales of improved stoves; and

(c) the improvement of the living conditions of urban households in the lower income classes by reducing their energy expenditures.

3. The activities to be undertaken are:

(a) involving one or more NGO's and/or private organizations in the sale and distribution of improved stoves; these organizations should themselves finance their stove activities, and eventually also arrange for quality control of the stoves they sell;

(b) arranging for (through the intermediary of a national specialist/quality controller) technical training of stove producing artisans, and organizing direct links between stove producers and sales points;

(c) diversifying the stove models promoted by the project, notably the "Rondereza" which is commercialized in Rwanda;

1/ *The project was introduced under CR-1049BU (Urban Development Project Bujumbura), and followed up under CR-1593BU (Power Distribution and Transmission Project).*

(d) continuing the publicity campaign for a limited period of time, until the private sector has taken over the commercialization of the stoves;

(e) administering several surveys consisting of: evaluating the penetration rate; assessing the reduction of charcoal consumption on a city-wide basis as well as on a household basis; evaluating the degree of commercialization; verifying the effectiveness of quality control; and

(f) preparing the commercialization of improved stoves in secondary cities, taking into account the results in Bujumbura.

4. It is envisaged that the project's activities in Bujumubura will be discontinued as soon as the stove production/marketing has become commercialized and/or fully privatized. In that case, the project will take a low-key role in verifying progress made by the private sector and, if necessary, providing limited assistance.

5. The organizational setup will be determined after a later mission. The General Directorate of Women Advancement and Social Protection is responsible for improved charcoal activities.

Budget

6. The total budget of the activity is estimated at US$315,000 over three years and is broken down as follows:

	US$
Consultants	64,000
Local personnel	108,000
Promotional activities	62,000
Equipment and operational costs	81,000
Total	315,000

IMPROVED CHARCOAL EFFICIENCY PROGRAM

Outline of Project

Introduction

1. Charcoal is the first choice for urban households when they switch away from firewood. Substitution towards modern fuels on any significant scale is unlikely over the medium term. On the contrary, the use of charcoal is expected to rise faster than the population growth: the urbanization rate will increase due to the high population density giving rise to increased use of charcoal, and the modernization process will intensify this effect.

2. Unfortunately, important data are lacking to correctly classify and categorize the actual production, transport and distribution of charcoal. The relations between all primary actors in this sector are unknown, as are the geographical locations of production, types of wood resources used, etc. It is confirmed however, that the traditional process of charcoal production is inefficient but can be improved with relatively simple measures. The traditional charcoaler, however, does not have the means nor the knowledge to improve the efficiency of production. Wood owners are likely to benefit from more efficient production methods as they will be able to obtain higher prices for their wood.

3. Therefore, since charcoal is a fuel that will remain important in the future in Burundi, and because efficiency gains in the production process will alleviate pressure on existing forestry resources as well as generate higher revenues for charcoalers and wood resource owners, it is recommended to launch a series of improvements in the charcoaling sector.

Objectives, Scope of Work

4. The objectives of the project are two-fold: reducing the wood used for the production of charcoal by introducing energy efficiency improvements; and improving the living conditions of the principal actors of the charcoal sector (charcoalers, wood owners, retailers, etc.).

5. The following actions would be undertaken as part of or in connection with the project:

(a) preparation of an inventory of the charcoal sector, (charcoalers, wood owners, location/type of wood, transporters, wholesalers, retailers, price structure , relations among all these actors, etc.);

(b) the organizing of training sessions and demonstrations for traditional charcoalers in improved charcoaling techniques like Casamance, Subri-Fosse, etc;

(c) the creation of an association of professional charcoalers;

(d) the organizing of an awareness campaign to address deforestation problems and potential solutions to the population, in particularly to charcoalers;

(e) the establishment of closer cooperation between wood owners and charcoaling associations by providing assistance to these associations on management issues, book keeping, negotiating, etc.;

(f) the review of the level and structure of wood and charcoal prices/taxes in order to encourage the use of improved charcoaling techniques; and

(g) the preparation of a plan for commercializing charcoal produced in existing wood plantations, particularly in pine plantations.

6. The following three organizations will be involved in the project:

a. la Direction Générale de l'Energie (DGE) du Ministère de l'Energie et des Mines (MEM);

b. le Départment de l'Energie Rurale (DER) de la Direction Générale de l'Hydraulique et de l'Energie Rurale (DGHER), Ministère du Développement Rural (MDR); et

c. le Département des Forêts (DF) de la Direction Générale des Eaux et Forêts (DGEF), Ministère de l'Aménagement, de l'Environnement, et du Tourisme (MAET).

Each of these institutions will have specific responsibility(ies), which are not overlapping. The project coordinator will ensure coordination between these institutions.

Budget

7. The total budget of the activity is estimated at US$615,000, of which Government contribution should be US$35,000 (in kind). It is broken down as follows:

	US$
Consultants	232,000
Local Personnel	65,000
Training, demonstration & research	157,000
Sensibilization/publicity campaign	25,000
Material and operational expenses	101,000
Government contribution	35,000
Total	615,000

Table 1: WOOD PLANTATION ESTABLISHMENT COSTS, MAGEYO

		Costs (US$/ha)
Site preparation		37
Seedlings		150
Transport		9
Planting		61
Maintenance		137
Fertilizers		21
Supervision		122
Thinning }	Maintenance in	52
Pruning }	year 6	43
Misc. }		7
Total		639

Source: Mission Forestière CZN, 1988

Note: Establishment costs are quite site specific, and the figures cannot be taken as generally valid. The cost of US$639/ha includes cost of tools as well as maintenance costs until first cutting in year 6. Costs for village plantations are much lower, but so is their output; output from commercial plantations varies from below 10 to over 40 m3/ha/year.

Table 2: LONG-RUN MARGINAL COSTS OF WOOD - MAGEYO INDUSTRIAL PLANTATION 1/
(US$)

Year	Cost/ha Establis-ment	Cost/ha Maint.	Cost/ha Cutting	Total	Wood/ha M.A.I. m3/yr	Wood/ha Cut m3/yr	Standing Stock m3
1	537		0	537	8		8
2			0	0	12		20
3			0	0	20		40
4			0	0	20		60
5			0	0	20		80
6		102	50	152	20	40	60
7			0	0	20		80
8			0	0	20		100
9			0	0	20		120
10			0	0	20		140
11			0	0	20		160
12			40	40	20	32	148
13			37	37	20	30	138
14		102	35	137	20	28	131
15			33	33	20	26	125
16			31	31	20	25	120
17			30	30	20	24	116
18			29	29	20	23	113
19			28	28	20	23	110
20			28	28	20	22	108
21			27	27	20	22	106
22		102	27	129	20	21	105
23			26	26	20	21	104
24			26	26	20	21	103
25			26	26	20	21	103
26			26	26	20	21	102
27			26	26	20	20	102
28			25	25	20	20	101
29			25	25	20	20	101
30			151	151	20	121	0
Total	537	306	725	1,568	580	580	
NPV	588	97	126	711	171	101	

Source: Mageyo Project; Mission estimates.

Long-run marginal cost of wood in an industrial wood plantation:	US$	7/m3
	BUF	1,127/m3
	BUF	1,734/MT
	BUF	845/stere

Assumptions:

- Establishment costs: See Table 1
- Costs per stere of wood cut (BUF 150) taken from Gakara (Forestry II Project)
- Mean annual output: 20 m3 with three 8-10 year rotation periods.
- Rate of discount: 10%
- Price level refers to 1988

1/ A 330 ha plantation of Eucalyptus, located 35 km from Bujumbura, managed by CZN.

WOOD PRODUCT PRICES - MAGEYO PLANTATION - 1988

Product	Qantity sold (m3)	Sales Price (BUF/stere)	% of plantation output (Volume)	(Revenue)
Firewood	500	398	36.4	11.7
Wood for charcoal	20	658	1.5	0.8
Long poles	657	1,546	47.9	59.8
Short poles	12	1,351	13.4	14.6
Tool handles	184	18,587	0.9	13.1
	1,373		100	100

Source: Project CZN

1. The volume and distribution of wood for various purposes for this second year of operation at this plantation are not representative and cannot be regarded as indicative for post-trial operations. The interesting figures are the sales prices per stere for different wood products, reflecting both the increasing quality of the wood and the amount of work gone into producing the products. Two benchmark "cost" figures may be mentioned in this connection: the official stumpage fee of BUF415/stere and the LRMC figure for this plantation of BUF845/stere (see Annex 3.9).

2. Uses of wood for other purposes than for woodfuel obtain higher market prices, as shown in the table and could quite possibly mean a higher implicit market value of wood for certain purposes and a compensation for the "subsidization" of wood for fuel. However, wood for other uses than fuelwood makes up only some 5-10% of total wood consumption. Higher priced wood for other uses therefore does not materially affect the average valuation of commercialized wood in the country (which otherwise could have contributed to more correct overall pricing from an efficiency point of view), nor can they to any significant degree be counted on to make public plantations profitable.

PRICE STRUCTURE OF A BAG OF CHARCOAL (45 kg)

Item	Financial Price BUF	Economic Cost BUF
Wood cost	190	845
Labor costs	150	115
Depreciation of utensils	10	10
Price roadside	350	970
Transport 35 km	60	55
Taxes	10	-
Distribution margin	330	155
Retail price Bujumbura	750	1,200 (rounded)

Source: Mission

Main Assumptions:	Financial	Economic
Wood cost	Residual value	From Annex 3.9. 100 m3 of Charcoaling efficiency 10% (weight basis)
Labor cost	Payment per bag to charcoalers	75% shadow pricing of financial cost
Transport	BUF 40 per MT/km	BUF 35 per MT/km
Distribution margin	Implied value	15% to cover real costs of distribution
Roadside and retail price	Actual prices	Sum of preceding cost elements

Note that the calculations are presented for illustrative purposes only. Lack of proper knowledge of the charcoal supply chain and of retail data preclude any claim of accuracy. The price structure in financial terms refers to a supply chain based on wood from private plantations, which reportedly are the major source of commercialized wood. The wood cost (and distribution margin) is a residual or implied value based on otherwise observed or estimated figures. The cost structure in economic terms assumes wood supplied from public plantations, where the cost of wood can be calculated from investment and operating elements. No information on the latter is available from private plantations. The difference in wood cost and, in the end, in the cost of charcoal may be explained by several factors: possibly more efficient management of private plantations; the fact that seedlings to private persons are subsidized; and the likelihood that labor costs associated with the establishment and operation of private plantations are not properly accounted for or reflected in the cost of wood. Whatever the reasons, it seems reasonable to conclude that (a) the present market (financial) price of charcoal does not properly reflect the real cost of wood and (b) the present distribution margin is high, possibly reflecting the combined effect of low cost of wood and higher costs of alternative fuels.

CONSUMPTION OF PETROLEUM PRODUCTS 1981-1988
(MT)

Product	1981	1982	1983	1984	1985	1986	1987	1988
Gasoline	14828	15386	15488	15309	16053	16436	17699	19366
Diesel	14270	16204	19952	15978	20774	16178	20838	19332
Fuel oil	3648	4309	4610	5570	6338	5674	7497	7592
Kerosene	1524	1626	2228	2437	2189	1495	2127	1604
Jet JP1	3780	4317	4706	4802	4373	2469	3725	4780
Avgas	77	100	77	57	54	26	70	47
LPG								150
Total	38127	41942	47061	44153	49781	42278	51954	52870

Average annual growth 1981-1988: 4.8%

Source: SEP

PROJECTED CONSUMPTION OF PETROLEUM PRODUCTS 1988-2000
(MT)

Product	Actual 1988	1989	1995	2000	Annual growth 1989-95	1995-20
Gasoline	19,366	21,170	28,370	34,516	5.0	4.0
Diesel	19,332	21,100	28,276	33,583	5.0	3.5
Jet JP1	4,780	6,150	7,782	9,468	4.0	4.0
Kerosene	1,604	1,650	1,970	2,284	3.0	3.0
Fuel Oil	7,592	7,930	10,034	11,917	4.0	3.5
Avgas	46	50	50	50	0	0
LPG	150	159	225	274	6.0	4.0
Total	52,870	58,209	76,707	92,092	4.7	3.7

Source: 1988:SEP
1989/2000: mission estimates

Assumptions:

1. Expected international oil price increases in real terms (World Bank projections 1989-2000: 22% in real terms) are not expected to have any major impact on demand as they filter through to the retail level in Burundi. Retail prices in Burundi are in the future expected to follow fairly closely movements in the intenational markets and in the neighboring countries, although an initial rise in Government duties and taxes would cause a correspon[illegible] increase in domestic prices.

2. Gasoline consumption will increase by 5% p.a. up to 1995 and by 4% p.a. thereafter, reflecting the uncertain expectations for GDP growth and certain efficiency gains.

3. Diesel demand will basically follow the same pattern as gasoline, although a conversion of diesel to fuel oil may take place in power plants during the forecasting period, which is taken to imply a 5% and a 3-1/2% annual growth before and after 1995.

4. Increases in air traffic will more than outweigh fuel efficiency improvements in aviation; jet fuel consumption is expected to increase by 4% p.a. throughout the period.

5. Household use dominates kerosene demand which is assumed to increase by the same rate as expected population growth, i.e. 3% p.a. over the forecasting period.

6. In certain industries, conversion from fuel oil to electricity or to peat as a fuel is a possibility during the forecasting period. A reduction in fuel oil consumption may be counterbalanced to some extent by conversion of thermal power plants from diesel to fuel oil. On balance, and as no new major industrial user is assumed, somewhat lower annual growth rates than for the two other major petroleum products are assumed, i.e. 4% and 3-1/2% before and after 1995.

7. Aviation gasoline, like elsewhere, will show no growth.

8. LPG is expected to grow by 6% and 4% p.a., respectively, before and after 1995.

BURUNDI: 1988 SALES VOLUMES BY PRODUCT AND COMPANY
(m3)

	Fina/BP	%	Sicopp	%	Petrobu	%	Cobuco	%	Hydrobur	%	Total
Gasoline	8,024	30.0	3,923	14.7	4,273	16.0	3,467	13.0	7,024	26.3	26,711
Kerosene	769	37.3	422	20.5	205	10.0	115	5.6	546	26.6	2,057
Diesel	5,639	24.4	4,586	19.8	3,504	15.1	3,089	13.4	6,313	27.3	23,130
Fuel Oil	1,540	19.1	2,558	31.6	1,277	15.8	1,465	18.1	1,245	15.4	8,085
Avgas	16	41.7	22	58.3	-	-	-	-	-	-	38
Jet JP1	6,128	100.0	-	-	-	-	-	-	-	-	6,128
Total	22,116	33.4	11,511	11.4	9,259	14.0	8,136	12.3	15,128	22.9	66,150

Source: Fina/BP

BURUNDI: OFFICIAL PRICE STRUCTURE OF GASOLINE, NOVEMBER 1989

		Kigoma	Dar es Salaam	Nairobi
1.	Cost of product (US$/MT):			
	Platt's FOB Italy	192.42	192.42	192.42
	Freight + Insurance	27.00	27.00	27.00
	Losses & Port Duties	4.77	4.77	4.77
2.	Import margin	19.24	19.24	19.24
3.	Transit in depots			
	Dar es Salaam	14.40	14.40	-
	Kigoma	10.80	-	-
4.	Pipeline transit	-	-	52.33
5.	Cost FOB/FOT US$/MT	268.63	257.83	295.76
6.	Transport (US$/m3)			
	Dar es Salaam-Kigoma (TRC)	74.00	-	-
	Kigoma-Bujumbura (barge)	7.81	-	-
	Dar es Salaam-Bujumbura (road)	-	174.82	-
	Nairobi-Bujumbura (road)	-	-	153.26
7.	Cost CIF Bujumbura			
	US$/m3	277.91	363.04	369.16
	BUF/l	44.48	58.10	59.09
8.	Transit SEP	1.40	1.30	1.30
9.	Commercial margins			
	Wholesale	11.50	8.50	8.50
	Retail	3.50	3.50	3.50
10.	Government revenue			
	Duties + taxes	3.96	4.26	4.31
	Road tax	5.00	5.00	5.00
	Fonds de regularisation	6.00	6.00	6.00
	Fonds special carburants	24.16	13.34	12.30
11.	Price at pump (BUF/l)	100.00	100.00	100.00
Summary:	(US$/MT)			
Cost CIF port of entry		224.19	224.19	224.19
Inland transport		137.27	253.88	262.28
Commercial margins:				
Import		19.24	19.24	19.24
Wholesale		110.41	83.88	83.88
Retail		29.96	29.96	29.96
	Subtotal	159.61	133.08	133.08
Government revenue		344.83	244.75	236.35
	Total	855.90	855.90	855.90

Source: Direction Générale du Commerce.

POTENTIAL PRICE REDUCTIONS FOR PETROLEUM PRODUCTS

Negotiations should be initiated for the supply of petroleum products consumed in the country over a period of time of two years, in a total for approximately 100,000 MT, subject to a schedule of timing and products to be indicated. The aim of the negotiations would be to obtain a price formula based on quotations on the international market plus a differential that may be calculated to US$80/MT in the case of FOT Nairobi and US$44 in the case of Dar es Salaam. The explanation for these differentials is as follows (see also Annex 4.4):

US$/MT	Nairobi		Dar es Salaam	
	New	Current	New	Current
Freight and insurance	17.00	27.00	17.00	27.00
Transit in Nairobi (pipeline)	55.00	52.33	-	-
Transit in depot	-	-	19.00	14.40
Losses and port duties	-	4.77	-	4.77
Import margin	8.00	19.24	8.00	19.24
	80.00	103.34	44.00	65.41

The prices resulting from this formula would be for products FOT truck from depot in Nairobi, and FOT tank-wagon or FOT truck from depot in Dar es Salaam. In both cases, the US$4.77 for losses and port duties would be included in the new transit fees in Nairobi or in the Dar es Salaam depot. It does not make sense to be paying losses in maritime transportation and port duties in the case of products of local production.

As indicated, there should be scope for a reduction in product prices of at least US$20/MT (BUF 2.50/l).

PETROLEUM PRICE STRUCTURE - SOME RECOMMENDATIONS AND COMMENTS

The comments refer to Table 4.3 in the text which uses the price of gasoline transported via Kigoma as an illustration. The point of departure is the price CIF Bujumbura (see Annex 4.4). Proposed changes are shown in the table.

(a) Droits d'administration: Equivalent to 1% of FOT/FOB price. This is an administrative tax that exists in almost all price structures in Africa.

(b) Droits d'entree, taxe de service et patente: These taxes exist also in most parts of Africa. In general, governments react to their discontinuation or simplification because they correspond to budgetary formulas that were inherited from the colonial administrations. Only an overall simplification of national budgets and accounts would justify their replacement which is therefore premature at present.

(c) Transit in the SEP depot: This fee is BUF 1.40/l in the case of products from Kigoma and BUF 1.30 in the other cases. The fee is higher in the Kigoma case because it covers the unloading from the barges. It is a little high but it is preferable to maintaining it provided that SEP continues to provide the same quality of service. In reality, the operators will continue to pay BUF 1.50/l, taking the difference from their margin.

(d) Wholesale margin: This margin is now BUF 8.50/l on products imported from Nairobi, Mombasa or Dar es Salaam and BUF 11.50/l when imported via Kigoma. Expressing these margins in US dollars/MT, they are, in the case of premium gasoline, 72.75 and 98.40, respectively. There is, thus, an incentive of $25.65 for imports via Kigoma. An increase in this incentive would at present have no impact since this route is already saturated. An incentive to use the road from Dar es Salaam should be considered as part of a review of the whole price structure.

The wholesale margin has, since its simplification in 1988, constituted the payment for the overall activity of the petroleum operators, with the exception of the storage in the SEP depot. The petroleum operators complain that their commercial margins include technical components that are outside their control in the case of leakages and losses in storage. This is not exactly true to the extent that they control the SEP operation, responsible for these potential losses. As stated earlier, it would be desirable to include the SEP fee in the wholesale margin. If one adds the SEP fee of BUF 1.30 or 1.40/l according to the source of product, correspond-ing to US$11.13/MT and US$11.98/MT in the case of gaso-line, one arrives at a total wholesale margin of US$83.88 and US$110.41, respectively. This wholesale margin is a fair remunera-tion for the activity and its related investments; moreover, it compares favorably with the same margin in some other African countries, ranging from US$60.33/MT in Mauritania to US$89.50/MT in Mali. Based on observations in Burundi, the retail network is well maintained and has a good appearance for African standards and this confirms the observation that the petroleum companies' margin is fair.

(e) Fonds routier national: This tax is applied only on gasoline and diesel and is in principle destined to the maintenance of the national road network. The amount, BUF 5.00/l, has been unchanged since 1979. It contributes only to a very modest extent to the needs for road maintenance. The equivalent in US$/MT is 42.80. Again, this tax in some African countries varies from US$46.00 in Mauritania to US$168.00 in Mali. The Government's budget for 1990 envisages BUF 800 million for road maintenance. At its present rate, 5%, the road tax will generate only BUF 250 million. As a first step in the right direction, it should be at least be doubled.

(f) Fonds de regularisation: This tax includes two previous taxes: "caisse transport" and "caisse fluctuation du dollar". The objective of the tax is to create a fund to compensate the petroleum operators for the cost of the distribution to the interior parts of the country in order to maintain a single price all over the country, and to absorb fluctuations in the exchange rate of the dollar between the date of purchase of the product and the date of its payment. The tax has been administrated by the operators themselves. This situation favors the operators who concentrate their activity in the main centers of consumption.

The tax should be discontinued as it is now and its value, BUF 6.00/l, should be included in a new petroleum tax. The operators must be reimbursed the cost differences of distribution outside Bujumbura according to tariffs to be agreed upon between themselves and the Government. Their reimbursement must be made quarterly and a posteriori according to the volumes actually distributed to the points of sale in the interior of the country. The data bank existing in the Departement de Recherches et Statistiques in MEM has the elements to control the volumes actually delivered.

(g) Fonds special carburants: This is a buffer tax collected in accordance with the FOB costs and related changes in the price structure. The variations in the value of this tax are considerable which may create budgetary problems for the Government. The tax has benefitted from the windfall decline in international prices but this is not likely to continue and it should consequently be replaced by a fixed tax per product subject to annual reviews, all fluctuations in the international market being passed to the final customer.

(h) Retail margin: This is a flat margin of BUF 3.50/l, equivalent to approximately UScents 8.30 per gallon which is quite acceptable taking into consideration the small sales volumes of each service station.

PETROLEUM UNIT WITHIN THE DIRECTION GENERALE DE L'ENERGIE

Main Tasks and Responsibilities

The main tasks of the unit will be to assist the Government in planning and follow-up with respect to supply, transportation, storage, distribution and pricing of petroleum products and give advice on policy matters in close cooperation with the Direction Générale du Commerce. Its primary functions would be to:

(a) monitor the international market for petroleum products on an ongoing basis. Frequent contact with counterpart authorities of neighboring countries would be important to exchange ideas and find solutions to common problems. Contacts with refineries in the region and international petroleum traders would also be necessary.

(b) follow the development of the domestic market. A good data bank already exists in the"Departement des Recherches et Statistiques" but it needs to be completed with information on prices broken down into CIF prices at the port of reception, handling, transit fees and freights;

(c) initiate a joint procurement arrangement between the petroleum operators in Burundi and participate in the first phases of negotiations with potential suppliers;

(d) promote the idea of a concerted regional supply system for Burundi, Rwanda, Uganda and Zaire's Kivu Province as a term solution to take advantage of economies of scale;

(e) monitor the development with respect to overland transportation of petroleum products and take necessary initiatives to promote economic solutions for the country;

(f) evaluate the size of strategic stocks, prepare a contingency plan for the use and replenishment of such stocks;

(g) study the needs for storage facilities and plan the future integration of the Gitega depot with the current SEP storage facilities in Bujumbura;

(h) review the pricing and taxation of petroleum products and propose new price structures that are to be monitored on a monthly basis to ensure that: a) prices correspond to the parity cost CIF port of entry; b) transport costs are correct (without "interfering" with the transport industry.); c) handling/transit fees outside and inside Burundi are correct; and d) distribution margins are in accordance with the costs and investments required to ensure rational supply and distribution of petroleum products;

(i) promote economically justified petroleum products substitution and conservation

(j) maintain a permanent and transparent dialogue with the petroleum operators through periodic meetings and discussions of the problems of the petroleum subsector.

BURUNDI - URBAN AND RURAL CENTERS WITH ELECTRIC SERVICE

Province		Center	Operator	Description
1.	Bubanza	Bubanza	REGIDESO	Interconnected network
		Gihanga	REGIDESO	Interconnected network
		Mpanda	REGIDESO	Interconnected network
		Musenyi	REGIDESO	Interconnected network
		Muzinda	REGIDESO	Interconnected network
		Randa	REGIDESO	Interconnected network
		Rubirizi	REGIDESO	Interconnected network
2.	Bujumbura	Bujumbura	REGIDESO	Interconnected network
		Ijenda	REGIDESO	Interconnected network
		Manga	REGIDESO	Interconnected network
		Mugongo	REGIDESO	Intersonnected network
		Mutambu	REGIDESO	Interconnected network
		Mugerero-SRDI	REGIDESO	Interconnected network
		Rwibaga	REGIDESO	Interconnected network
3.	Bururi	Bururi	REGIDESO	Connected to Nyemanga
		Buta	REGIDESO	Connected to Nyemanga
		Kiremba	REGIDESO	Connected to Nyemanga
		Gasanda	REGIDESO	Connected to Nyemanga
		Kigwena	DGHER	Micro-hydro of Kigwena
		Mugamba - Tora	REGIDESO	Interconnected network
		Rumonge	REGIDESO	Connected to Nyemanga
4.	Cankuzo	Cankuzo	REGIDESO	Isolated diesel plant
		Murore	DGHER	Micro-hydro of Murore
5.	Cibitoke	Cibitoke	REGIDESO	Interconnected network
		Rugombo	REGIDESO	Interconnected network
6.	Gitega	Gitega	REGIDESO	Connected to Ruvyironza
		Giheta	DGHER	Micro-hydro of Giheta
		Mutaho	REGIDESO	Isolated diesel plant
		Mutoyi	REGIDESO	Connected to Ruvyironza
		Mweya	REGIDESO	Connected to Ruvyironza
		Nyabihere	DGHER	Micro-hydro of Nyabikere
7.	Kayanza	Kayanza	REGIDESO	Interconnected network

7.	Kayanza	Kayanza	REGIDESO	Interconnected network
		Rwegura	REGIDESO	Interconnected network
8.	Kirundo	Kirundo	REGIDESO	Connected to Marangara
9.	Makamba	Makamba	REGIDESO	Isolated diesel plant
		Nyanza-Lac	REGIDESO	Isolated diesel plant
10.	Muramuya	Muramuya	REGIDESO	Connected to Gikonge
		Bukeye	REGIDESO	Connected to Gikonge
		Gisozi	REGIDESO	Interconnected network
		Kibumbu	REGIDESO	Interconnected network
		Kiganda	DGHER	Micro-Hydro of Kiganda
		Mwaro	REGIDESO	Interconnected network
		Remera	REGIDESO	Connected to Gikonge
		Teza	REGIDESO	Connected to Gikonge
11.	Muyinga	Muyinga	REGIDESO	Connected to Kayenzi
12.	Ngozi	Ngozi	REGIDESO	Interconnected network
		Akanyaru-Haut	REGIDESO	Interconnected network
		Busiga	REGIDESO	Interconnected network
		Marangara	REGIDESO	Connected to Marangara
13.	Rutana	Rutana	REGIDESO	Isolated diesel plant
14.	Ruyigi	Ruyigi	DGHER	Micro-Hydro of Ruyigi
		Butezi	DGHER	Connected to Butezi
15.	Karuzi	Karuzi	DGHER	Connected to Buhiga
		Buhiga	DGHER	Connected to Buhiga.

Source: REGIDESO, DGHER

COMPARISON OF DEMAND PROJECTIONS 1/
(GWh)

		1989	1990	1995	2000
1.	ESMAP present report	93.8 2/	99.4	133.1	178.1
2.	Electricité de France, Plan directeur de l'électrification, Dec. 1988				
	- low growth scenario	122.7	135.3	190.3	245.0
	- high growth scenario	138.1	158.2	232.3	306.5
3.	Energie des Grands Lacs (EGL), Rentabilisation de la Centrale Communautaire de Ruzizi II, October 1987 3/	89.9	101.1	114.9	-
4.	NORCONSULT, Kagunuzi Multipurpose Project Feasibility Study, June 1987 3/	124.8	138.2	218.7	301.7
5.	World Bank, Power Transmission and Distribution Project (Cr. 1593-BU) Staff Appraisal Report (1985)	111.3	122.6	206.9	-
6.	Lahmeyer International, Etude de Développement des Ressources Hydroélectriques du Burundi, 1983		171.2	218.8	301.4

Source: Various Demand Forecasts; Mission

1/ Excludes DGHER and auto-producers
2/ Actual figure
3/ Only for the interconnected system of REGIDESO.

BURUNDI - Energy and Capacity Balances For REGIDESO

	1989 a/	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Demand (GWh)												
a. Projected Consumption b/	93.8	99.4	105.4	111.7	118.4	125.5	133.1	141.0	149.5	158.5	168.0	178.1
b. Losses c/	23.5	24.9	24.7	24.5	24.3	23.9	23.5	23.0	24.3	23.7	25.1	24.3
c. Required generation	117.3	124.3	130.1	136.2	142.7	149.4	156.6	164.0	173.8	182.2	193.1	202.4
2. Supply (GWh)												
a. Domestic plants d/	103.4	102.0	102.0	102.0	102.0	102.0	102.0	102.0	102.0	102.0	102.0	102.0
b. Ruzizi I e/	1.8	30.0	30.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
c. Ruzizi II f/	12.1	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7	46.7
3. Energy Balances (GWh) g/	-	54.4	48.6	25.5	19.0	12.3	5.1	(2.3)	(12.1)	(20.5)	(31.4)	(40.7)
4. Peak Demand (MW) h/	23.0	24.4	25.5	26.7	28.0	29.3	30.7	32.2	34.1	35.7	37.9	39.7
5. Installed Capacity (MW)												
a. Domestic plants i/	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
b. Ruzizi I	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
c. Ruzizi II	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
6. Capacity Balances (MW) j/	19.9	18.5	17.4	16.2	14.9	13.6	12.2	10.7	8.8	7.2	5.0	3.2

Source: Mission estimates.

a/ Actual figures. Supply includes 0.7 GWh from thermal power plants.

b/ Corresponds to an annual rate of growth of 6%.

c/ Losses decline from 20% in 1989 to 15% in 1995 and 12% in 2000.

d/ The guaranteed energy of each domestic hydroelectric plant is: Mugere 19 GWh; Rwegura 55 GWh; Ruvyironza 11 GWh; Gikonge 2 GWh; Kayenzi 1 GWh; Marangara 2 GWh, and Nyemanga 12 GWh, for a total of 102.0 GWh. Total average energy from these plants is 146.0 GWh.

e/ Corresponds to the present contractual arrangements with Zaïre. Available information for the Kivu region indicates that SNEL-Zaire could provide at least 42 GWh before the construction of the line Goma-Butembo-Beni.

f/ Corresponds to 1/3 of the energy of Ruzizi II with two units. New information about hydrology indicates that total energy available from Ruzizi II could be 197 GWh instead of the 140 GWh used here.

g/ A figure in parentheses indicates a negative amount.

h/ Calculated from the required generation using 5,100 hours of utilization.

i/ Does not consider thermal plants. The installed capacity of each domestic plant is: Mugere 8.0 MW; Rwegura 18.0 MW; Ruvyironza 1.3 MW; Gikonge 0.85 MW; Kayenzi 0.85 MW; Marangara 0.26 MW; Nyemanga 1.4 MW.

j/ Does not consider any reserve requirements. However, there are about 5 MW available in thermal power plants and the power from Ruziz I could be increased up to 8.8 MW if needed, which gives a total theoretical reserve of 10.4 MW.

A. Characteristics of Micro-Hydro Plants Installed

Plant	Operator	Installed Capacity (kW)	Year Installed	Observation
Ryarusera	DGHER	22	1984	Commune of Muramvya
Kigwena	DGHER	50	1984	Commune of Kigwena
Giheta	DGHER	30	1984	Commune of Giheta
Nyabikere	DGHER	140	1988	Commune of Nyabikere
Sanzu (Ruyigi)	DGHER	72	1982	Commune of Ruyigi
Murore	DGHER	24	1987	Commune of Gisagara
Muhuta	Mission	50	1980	Commune of Muhuta
Masango	Mission	60	n.a.	Commune of Bukinanyana
Cibitoke	Cooperative	68	n.a.	Not in operation
Teza	Tea factory	360	1970	Commune of Bakeye
Gisozi	Isabu	15	n.a.	Commune of Gisozi
Kibumbu	Mission	56	n.a.	Not in operation
Kiganda	Mission	44	1988	Commune of Kiganda
Kiremba	Church	75	n.a.	Commune of Kiremba
Burasira	Church	20	n.a.	Commune of Ruhororo
Mugera	Mission	30	n.a.	Commune of Bugandana
Kibimba	Mission	50	n.a.	Commune of Giheta
Musongati	Mission	6	n.a.	Commune of Musongati
Mpinga	Mission	16	1984	Commune of Mpinga

B. Micro-Hydro Plants Studied

Plant	Operator	Observation
Bubanza	DGHER	Project postponed
Buhoro	DGHER	Commune of Itaba
Nyangwa	DGHER	Commune of Ryansoro
Butegana	Coffee factory	Commune of Busiga

Source: EDFI, Power Sector Master Plan

BURUNDI: LONG-RUN MARGINAL COSTS OF ELECTRICITY

1. The study "Etude de Restructuration des Tarifs d'Electricité" by Fernando Lecaros, December 1989, includes the following sections: (a) analysis of the demand for electricity, (b) examination of the Power Sector Master Plan prepared by Electricité de France Internationale and review of the investment proposals on the basis of recent perspectives; (c) calculation of the long-run marginal cost of electricity; (d) translation of the long-run marginal cost signal into tariffs and comparison with existing tariffs; (e) proposal of a new tariff structure; and (f) recommendations on tariff management and analysis of financial effects.

2. The analysis of demand concludes that increases in consumption of existing users will be limited by macroeconomic factors, while the connection of new consumers, which has a great potential, will be constrainted by the financial situation of REGIDESO. In these circumstances, the projections of the Master Plan as well as the recent studies of EGL and REGIDESO have proven to be too optimistic. However, an increase of consumption at about 6% per year may be reasonable. With these increases, existing power plants could satisfy the demand up to 1998 on the basis of average hydrology (up to 1994 on the basis of guaranteed energy).

3. To calculate long-run marginal cost, the KABU 16 power plant, which is the least cost alternative in the Power Sector Master Plan, is used as reference. For the marginal capacity a cost of US$800 per kW is used on the basis of estimates of the cost of increasing capacity in the possible new power plants. This is a somewhat conservative value, since the cost of installed capacity in Ruzizi II is estimated at US$864 per kW. Including the cost of operation at 2% of investment cost, the annual capacity costs are US$98 per kW-year. Energy costs at the generation level are US$0.029 per kWh (in 1987 prices).

4. Given the slower increase in consumption, the investments in transmission lines included in the Power Sector Master Plan were reduced in the calculation of the marginal cost. Only the lines RNI-Gitega, Bubanza-RNI (reinforcement) and Rwegura-Ngozi were included. Incremental costs of transmission including operational cost were estimated at US$181 per kW, without losses. Since investments in distribution follow more closely the demand, the original investment and consumption data of the Master Plan were used to estimate marginal cost in distribution. The calculations show substantial differences between Bujumbura and the rest of the country. Average values for the whole country are US$125 per kW-year for medium voltage and US$128 per kW-year for low voltage, excluding losses.

5. In summary, the reference values for the marginal cost in 1987 prices are the following:

Energy costs:

- At the production level: US$0.029 per kWh
- At medium-voltage level: US$0.032 per kWh
- At low voltage level: US$0.034 per kWh

Capacity costs (in US$ per kW)

	Initial	Medium Voltage	Low Voltage
- Production	98	108	116
- Transmission	181	199	214
- Medium-voltage Distribution	125	125	134
- Low-voltage Distribution	128	---	128

LIST OF RURAL ELECTRIFICAITON PROJECTS a/

1. Line Kivoga - Mbuye (16 km): 7.1 million Belgian Francs
2. Line Gahombo - Rukago (18 km): 10.0 million Belgian Francs
3. Line Mutumba - Rabiro (22 km): 12.6 million Belgian Franc
4. Line Kayanza - Gatara - Musema - Buraniro (20 km): 11.3 million Belgian Francs
5. Line Gitega - Makebuko - Buhoro - Butaganzwa (54 km): 26.0 million Belgian Francs
6. Line Muyinga - Rugari (15 km): 8.5 million Belgian Francs
7. Line Buhiga - Bugenyuzi (13 km): 7.4 million Belgian Francs
8. Line Rumonge - Minago (26 km): 17.2 million Belgian Francs
9. Line Gitega - Makebuko - Kibuye - Bukirasazi (42 km): 20.2 million Belgian Francs
10. Electrification of Rumeza and Ruvumvu: BUF 66.1 million
11. Electrification of Murago and Buyengero (includes a micro-hydroelectric plant): BUF 128.4 million.
12. Electrification of Nyangwa: BUF 75.8 million
13. Line Kayanza - Ruganza - Butegana - Rubura - Ruhminga (22 km): BUF 74.2
14. Line Ngozi - Ibuye - Kagoma - Kigaramo - Nyamurenza - Ruyenzi (26 km): BUF 89.7 million
15. Line Rwegura - Masango - Ndora - Bukinayana (34 km): BUF 91.0 million.
16. Line Rugombo - Nyeshenza (12 km): BUF 31.7 million
17. Line Bubanza - Musigati (14 km): BUF 35.7 million
18. Line Rugazi - Rivoga - Miheto (11 km): BUF 37.1 million
19. Line Kibumbu - Mbogora - Nyabihanga (16 km): BUF 47.2 million
20. Line Gatete - Karonda - Cabara: BUF 26.7 million

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a/ There are no technical or economic studies for these projects and no financing has been identified. The list is only an illustration.

Source: DGHER.

RURAL ELECTRIFICATION

Criteria for Project Acceptability

Introduction

1. Developing countries and donors are putting increased amounts of resources into rural electrification but, in may cases, projects are not subject to the same rigorous cost/benefit analysis that is recommended for other investment projects. Sometimes it is confusingly argued that rural electrification is justified on the basis of some non-quantifiable social benefits. In other cases, inflated and unrealistic tariff revenues are considered as the only benefits. The consequence of the erroneous analysis is that scarce resources are wasted in investments that are neither socially nor economically desirable and that the allocation of the limited funds available to the country is not done correctly.

2. This note explains how the social and economic justification of rural electrification projects should be done following the traditional methodology of cost/benefit analysis. Households, farms, agro-industries, and commerce derive benefits from the use of electricity and these benefits can be measured, as is customary practice in the appraisal of development projects, by the amount of income that these families and businesses are prepared to spend on electricity. The correctly measured benefits should be compared with the costs of the project, calculating the net present value and the internal economic rate of return, to determine if the project is desirable. Rural electrification projects with negative net present value or internal economic rates of return below the opportunity cost of capital should not be undertaken.

Forecasting Demand

3. The first task in the definition of a rural electrification project is to forecast demand for electricity over a reasonable period of time. The basis for this forecast is an exhaustive survey of the population and economic activities in the region of the project. The survey should be tailored to the area under investigation, but it should at least identify: (a) type and number of potential consumers; (b) socio-economic characteristics of consumers; (c) physical characteristics of houses; (d) principal economic activities; and (e) existing and potential uses of energy.

4. While surveys are normally undertaken in all rural electrification projects, demand forecasts based on them are generally too optimistic. The first point to consider is that existing consumers will not connect immediately to the electric grid. Sometimes this is due to the connection charges and tariff rates established by the electrical companies, but there is also quite a lot of social inertia in rural areas which results in low adaptation to changes. Evidence from the rate of connections in already executed similar projects should be used to make an adequate estimate of what would happen

in the new project. Another point to consider is that electrification per se will not automatically produce growth. For this to occur other investments in the region will have to be made. Regional development plans and budgets should be examined to forecast the growth in the number of each type of consumers, including population and businesses, and the experience of other areas should be used to forecast the level and growth of consumption per consumer. Street lighting and consumption of schools, health center, and other administrative offices can be estimated directly from available technical coefficients.

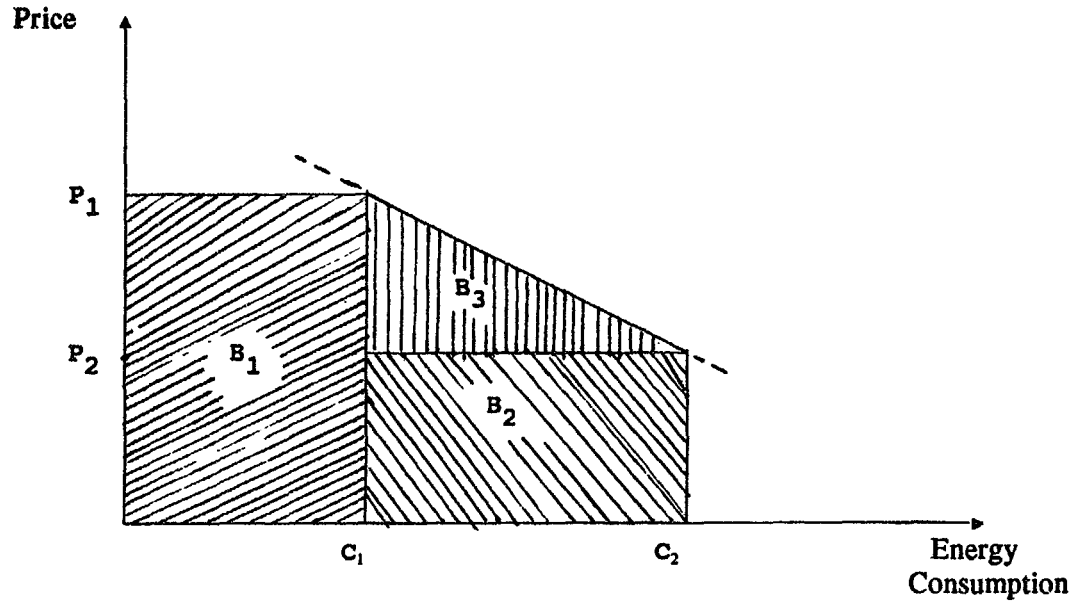
Analysis of Alternatives

5. Rural electrification is generally considered to be the extension of the national electric grid into a new area. But areas can also get electricity developing local sources, such as diesel-powered generators or local minihydro sites. For small consumption and/or for remote areas it is often cheaper to meet the electricity needs through local supply. In those circumstances, the capital costs of diesel generators are normally lower than the extension of the electric grid and compensate for the higher fuel and operating costs. This is the reason why, in the initial phases of electrification in isolated areas, private businesses may install their own generators and sometimes even partially supply a neighboring town.

6. In all rural electrification projects a comparison should be made between the development of local supply and the extension of the national electric grid. In a new locality it may be advantageous to install first diesel generators and then create a market for electricity. The interconnection to the electric grid will then be done only when consumption surpasses a certain minimum level. Governmental decision-makers and donors should insist that an analysis of alternative sources of electricity supply be done before embarking on the extension of transmission lines.

Calculation of Benefits

7. Demand curves should be constructed for the principal types of consumers in each project area. These curves are based on the surveys undertaken to forecast demand and should distinguish between: (a) the cost and kWh equivalency of current consumption of alternative forms of energy being used in the area (lighting, autogeneration, diesel engines, and other equipment to be substituted); and (b) projected future consumption of electricity at the prevailing tariff rates. A typical yearly demand curve is depicted below.



In the above diagram, "C_1" indicates the current level of consumption (in kWh equivalent) of alternative forms of energy. "P_1" indicates the implied price per kWh equivalent of that energy. "C_2" indicates the projeted level of consumption of electricity after the project. "P_2" indicates the prevailing tariff level charged by the company for that consumption. The area covered by rectangle "B_1" represents consumers' annual expenditures on (relatively expensive) alternative forms of energy in the "without project" situation. Rectangle "B_2" represents the additional amount of energy the consumer is expected to use as a result of the project (because of the fall in price) times the average electricity tariff rate. And triangle "B_3 represents the "consumer surplus", which is the difference between what consumers would be willing to pay for each additional unit of energy consumed and what they are actually charged by the electric company. The total benefit of the project is equal to the sum of areas "$B_1 + B_2 = B_3$", or

$$P_1 \times C_1 + P_2 (C_2 - C_1) + 1/2 (P_1 - P_2) (C_2 - C_1)$$

8. In order to calulate "B_1", expenditures on alternative forms of energy need to be estimated for each consumer group. In the case of households, commercial establishments, schools, and other administrative offices, electricity will principally be used as a substitute for fuels and candles currently used for illumination. In order to calculate the quantities involved, the numer of residential and other users in each project area must be multiplied by an estimate of the average level of fuel and candle consumption in non-electrified households. An allowance must also be made for the substitution of electricity in other uses (e.g., cooking, refrigeration). In the case of agricultural producers and agro-business, an inventory should be made of currently employed diesel powered machinery (by type and capacity). Using technical coefficients and assumed utilization factors, the total substitutable consumption of diesel oil can be calculated.

9. The quantities of fuel determined following the procedure of the above paragraph must be multiplied by their estimated CIF cost. This will give the total expected economic value of savings in alternative forms of energy (the area "B_1") in each project area. A caveat for the economic analysis is that in calculating the area "B_1", price "P_1" should be expressed in terms of economic prices (i.e., net of taxes and subsidies), whilst calculating the area of "B_3", price "P_1" should reflect actual market costs (including taxes and subsidies) because it defines the slope of the demand curve (and hence the area "B_3").

10. The area "B_2" is determined by the average price of electricity to rural consumers (price "P_2" in the diagram) and the increase in consumption of energy ("C_2" - "C_1") due to the fall in price (from ("P_1" to "P_2"). The level of "P_2" is generally a known data and the calculation of energy consumption in the "without project" ("C_1") has been described in para. 8 above. Energy consumption "with the project" ("C_2") can be estimated from data on average level of electricity consumption by type of consumers in recently electrified areas. In the case of residential consumers, average consumption should be broken down by size and type of dwellings. It must be noted that in the first years of electrification only a fraction of the potential consumers connect to the electric system. Also, energy consumption per household increases rapidly in the first year after connection as electric lights and priority appliances are purchased, and then declines reaching close to saturation levels near the fourth year. These facts should be considered in the estimation of electric consumption with the project.

11. The area "B_3", representing the value of the "consumer surplus", is calculated by multiplying the increase in energy consumption due to the project ("C_2" - "C_1") by the fall in the price of energy ("P_1" - "P_2"), times one-half. In this case, however, subsidies and taxes have been included in the cost of alternative forms of energy, since they represent part of the consumer's perceived cost in the "without project" situation. "P_1" was thus obtained by dividing the total consumer expenditure on alternative forms of energy before the project by the assumed initial energy consumption level "C_1".

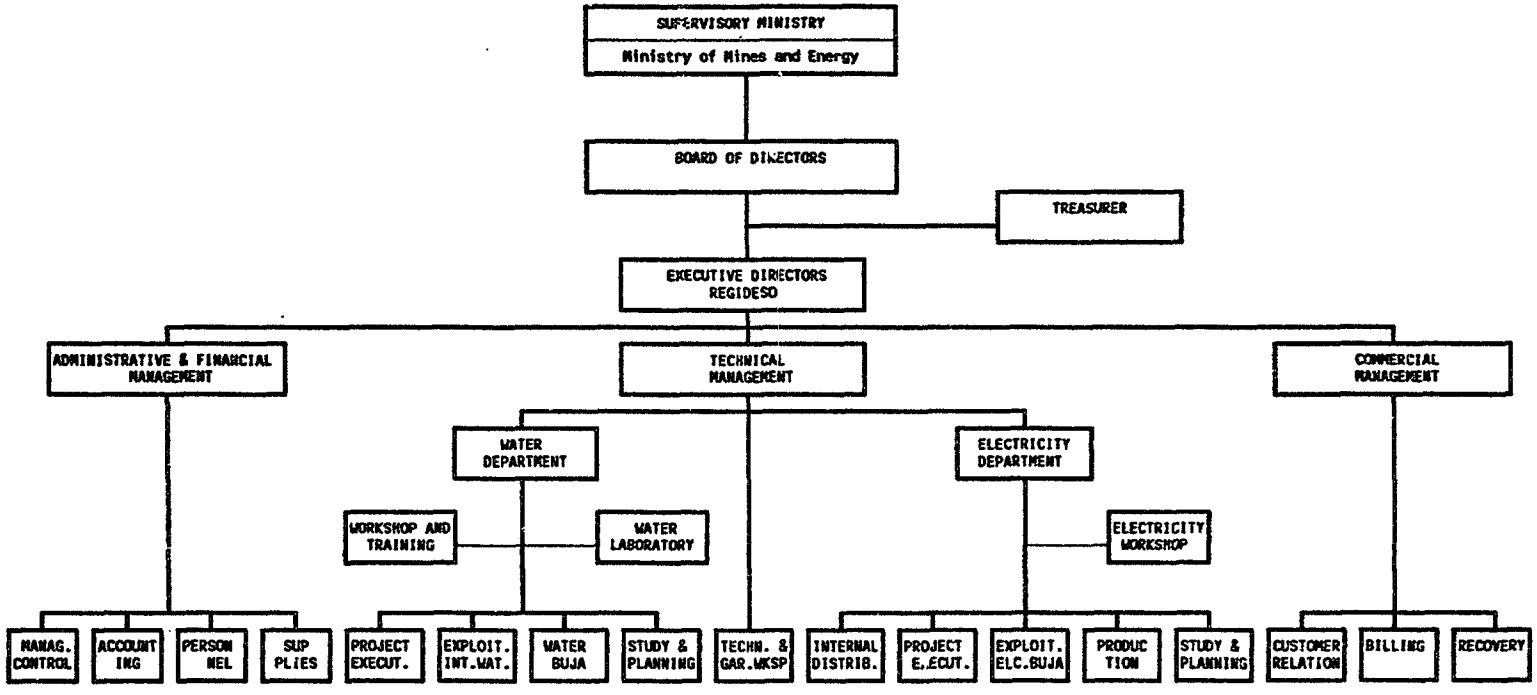
12. Practical experience indicated that benefits of energy substitution (area "B_1") and of consumer surplus (area "B_3") are generally more than 60% of the total benefits of a rural electrification project. When these benefits are not measured there is a huge under-estimation of benefits. Decisions based exclusively on tariff revenues will not justify most rural electrification projects and therefore consultants over-estimate demand to approach some acceptable internal economic rate of return.

Project Acceptability

13. Once demand and benefits have been estimated, it is necesssary to compare the time-stream of costs and benefits over the useful life of the project on a present worth basis. The calculation of net present values and internal economic rates of return follow customary practices of cost/benefit analysis. Shadow-price adjustments for foreign exchange and unskilled labor should be made on the basis of the country's macro-economic situation.

14. A rural electrification project should be executed only if the internal economic rate of return is greater than the opportunity cost of capital. When this is not the case, the contribution of electricity to raise income is limited and does not compensate for the resources used. Sometimes this may be due to the high cost of the project. In those cases, network layout and equipment capacity should be re-examined to find out if savings in investment costs are possible. But the low economic returns may also indicate that local economic activity is very small and that other investments are needed to develop the area. If this is the case, rural electrification should be postponed until the additional infrastructure is in place. The economic rate of return calculated according to sound cost/benefit analysis provides a clear signal of the adequacy of the proposed investment.

ORGANIZATION CHART OF THE REGIDESO



REGIDESO: Summary of Financial Accounts
(in million BUF)

	1987	1988	1989
Electricity revenues	1097.0	1117.2	1285.9
Water revenues	445.1	473.3	551.1
Other revenues	248.0	393.5	1073.0
Total Revenues	1790.1	1984.0	2910.0
Salaries	428.0	467.0	505.0
Other expenses	521.0	517.0	700.0
Depreciation	692.0	792.0	1210.0
Exchange losses	-	2502.0	2806.0
Interest	658.0	861.0	923.0
Total Expenses	2299.0	5140.0	6144.0
Net operating revenues	(508.9)	(3156.0)	(3234.0)
Exceptional profits (losses)	178.0	(205.0)	(69.0)
Profit (losses) of the year	(330.9)	(3361.0)	(3303.0)
Rate of return on net fixed assets a/	1.1%	1.1%	2.7%
Rate of return on net fixed assets b/	1.1%	-12.3%	-12.5%
Debt service coverage b/	0.2	-1.4	-1.1
Operating ratio b/	71.0	215.7	179.4
Debt/Equity ratio	...	-12.6	-5.7
Contribution to investment	...	52.6%	72.8%

a/ Excluding exchange losses
b/ Including exchange losses

Source:

LIST OF TRANSMISSION AND DISTRIBUTION PROJECTS 1/

A. Transmission

1.	Reinforcement of the 110 kv line Bubanga-RN1:	320 million BUF
2.	Line 110 kv Rivegura-Ngozi:	610 million BUF
3.	Reinforcement sub-station SNEL:	100 million BUF
4.	Line 30 kv Muyinga-Gasoho-Gasura:	50 million BUF
5.	Line 30 kv Ngozi-Gasoho:	135 million BUF
6.	Line 30 kv Ngozi-Mutaho:	148 million BUF
7.	Line 30 kv Gitega-Karuzi:	200 million BUF
8.	Line 30 kv Gitega-Ruyizi:	170 million BUF
9.	Line 30 kv Kayenzi-Muyinga:	15 million BUF

B. Distribution

1.	Distribution system of Gitega:	87 million BUF
2.	Distribution system of Kayanga:	52 million BUF
3.	Distribution system of Makamba:	55 million BUF
4.	Distribution system of RUTANA:	35 million BUF
5.	Distribution system of Ruyigi:	25 million BUF
6.	Distribution system of Cankuzu:	40 million BUF
7.	Distribution system of Matana:	33 million BUF
8.	Distribution system of Muramvya:	37 million BUF
9.	Distribution system of Mutaho:	42 million BUF
10.	Distribution system of Muyinga:	31 million BUF
11.	Distribution system of Bujumbura:	50 million BUF (per year)

1/ Costs are estimated at prices of January 1988.

Source: Electricité de France International, Plan Directeur National d'Electrification, Décembre 1988.

BURUNDI: FEASIBILITY STUDIES OF HYDROELECTRIC POWER PLANTS

Terms of Reference

Purpose of the Study

The study will examine the technical and economical feasibility of some of the most attractive hydroelectric sites available and choose the next invesment in power generation. On the basis of the Power Sector Master Plan prepared by Electricité de France Internationale in December 1988, the sites that should be studied are KABU 16, KABU 23, Mule 34, Jiji 06 and Rushiha. The feasibility studies of these sites, together with those of Kagunuzi, Ruzizi III and Rusumo Falls should be used to determine the next power plant development.

Scope of the Study

The consultants will undertake among other the following tasks:

(a) Topographic, geological and geotechnical studies of each site;

(b) Assessment of the available hydrological data;

(c) Choice of the capacity and other technical characteristics of the proposed power plant;

(c) Estimate of the investment costs for the power plant and associated transmission;

(e) Assessment of the environmental impacts;

(f) A detail feasibility study of two of the sites chosen on the basis of an economic comparison; and

(g) A completion and up-date of the Power Sector Master Plan.

BURUNDI: RURAL ELECTRIFICATION MASTER PLAN

Terms of Reference

Purpose of the Study

The Rural Electrification Master Plan will propose a comprehensive rural electrification program for the next five years that meets established technical, economic and social criteria. It will define the respective roles and responsabilities of DGHER and REGIDESO in the technical and commercial management of the rural electric network and the involvement of local communities and organization.

Scope of the Study

The consultants will undertake, among other, the following tasks:

(a) Assessment of existing power generating plants and distribution network of DGHER and estimates of the rehabilitation costs;

(b) Estimate demand projections for electricity in preselected rural centers that could be electrified;

(c) Identification of the technical solutions for supplying the preselected rural centers with electricity and selection of the economically most advantageous option;

(d) Evaluation and classification of possible projects according to the internal economic rate of return criteria;

(e) Assessment of the financial impact of the proposed Rural Electrification Master Plan;

(f) Identify local organizations that could assume the responsability of managing the selected electrified rural centers and define their relationship with REGIDESO and DGHER;

(g) Define the responsibilities of REGIDESO and DGHER in the technical management of the electrified rural centers;

(h) Assess the possibilities of the corresponding rural population to pay for electricity consumption and the introduction of credit mesures to facilitate the connection to the electric network;

(i) Assess the impact of the proposed Master Plan in the organizational structure of DGHER and identify training requirements; and

(j) Provide general terms of reference for the implementation of the projects.

CONVERSION OF BOILER TO PEAT FOR INDUSTRIAL PURPOSES

The cost of the two fuels used by the industrial sector in this comparison is as follows:

	BUF/unit	Unit	MJ/unit	Price/MJ
Fuel oil	69	l	35	2.0
Peat	8	kg	14	0.57

Source: DRS.

Typical energy requirements for a small scale boiler used in the industrial sector in Burundi are: 6.9 MW (steam), which when used during 300 days/year of 12 hours/day results in 24.84 GWh/year, or 89.424 million MJ. The energy efficiencies of fuel oil and peat boilers are approximately the same: 80%. The fuel replacement ratio of a peat boiler is 80%.

The fuel consumption of a fuel oil boiler and a peat boiler is as follows:

Fuel consumption		Before Conversion	After Conversion
- fuel oil	m3/year	2555	511
- peat	MT/year		5046
In monetary terms	US$1000/yr	1100	473

Investment costs and other costs to install, maintain and operate the peat boiler are the following:

	US$1000	
Investments		
- Boiler	630	
- Aux. equip	210	
Other costs		
- Training	63	
- Installation	315	
- Checkup	30	(Every 2 year)
Annual maintenance costs		
- Boiler	94.5	(15% of investment costs)
- Aux. equip	21.0	(10% ,,)
Additional labor (2)	6 per year	(@35,000 BUF/month/person

Source: Mission estimates, based on EMS Thermoplant (UK) data.

FINANCIAL CALCULATION (CASH FLOWS IN US$1,000)

Year	0	1	2	3	4	5	6	7
Boiler	630							
Aux equipment	210							
Maintenance	116	116	116	116	116	116	116	116
Labour	6	6	6	6	6	6	6	6
Installation	315							
Training	63							
Checkups		30		30		30		30
Avoided fuel costs	313	627	627	627	627	627	627	627
Total	-1027	475	505	475	505	475	505	475
IRR	44%							
NPV (at 10%)	1350							

Source: Mission, based on data from EMS Thermoplant (UK).
Conversion GBP/US$: 2.1/1.

PEAT CHARACTERISTICS IN BURUNDI

Table 1: ANALYSIS OF PEAT COMPOSITION (%)

Bogs	Gisozi	Gishubi	Gitanga
Carbon	49.5	45.5	39.0
Hydrogen	4.2	4.0	3.7
Nitrogen	1.5	1.5	1.3
Sulphur	0.3	0.5	0.6
Ash	7.1	14.8	24.6
Moisture	11.3	9.8	8.9
Oxygen (by difference)	26.1	23.0	21.0
	100.0	100.0	100.0
Calorific Value (MJ/kg)	20.5	18.6	17.6 1)

1) Oven dry basis. The average calorific value at 25% mcwb is 15 MJ/kg

Source: Bord na Mona.

Table 2: ANALYSIS OF PEAT ASH IN BURUNDI (%)

Bogs	Gisozi	Gishubi	Gitanga
Silica	47.5	40.6	55.2
Ferric Oxide	12.3	18.9	9.3
Alumina	31.8	25.5	28.0
Titanium Dioxide	1.6	1.6	1.8
Magnesium Dioxide	0.6	1.0	0.5
Calcium Oxide	2.1	5.7	1.6
Sodium Oxide	0.5	0.6	0.4
Potassium Oxide	1.4	1.5	1.2
Sulphur Trioxid	0.3	3.6	0.6
Phosphorus Pentoxide	1.2	0.5	1.0
Undetermined/errors	0.9	0.5	0.5

Source: Bord na Mona.

Ash contents are very high and vary enormously even within the bogs: average values within a bog range from 5 - 22.5% (Gisozi), 11.3 - 28.9% (Gishubi) and 11 - 41.5% (Gitanga). The gross anhydrous calorific values and volatile contents reflect these high ash levels, while correction to an ash-free basis results in excellent values for combustible peat. Ash fusion temperatures are higher than those normally encountered in Irish peats, but insufficient to compensate for the quantity of ash.

Sulphur contents are low, being generally less than 0.5% except in certain parts of the Gitanga bog. Chlorine contents are very low and acidity levels are not expected to cause any combustion problems.

For the user, this means that a special stove/furnace is required to remove (a) the ashes, and (b) the smell and smoke, which means that a chimney is needed to induce a sufficient draft.

FEASIBILITY STUDY OF PEAT SUBSTITUTION IN SELECTED INDUSTRIES

Outline of Study

Introduction

1. Peat can compete with electricity and petroleum products from a financial point view: at market prices the cost of peat per unit of energy is roughly one-fifth of that of these fuels. The economic competitiveness depends mainly on its end-use and on the type of equipment utilized. High technical and economic performance is achieved with simple solid fuels boilers (fire chambers) attached to existing boiler systems. Many units are in use in Ireland and other countries like Finland, Germany, and a number of them use peat as a fuel.

2. For various reasons (technical, environmental and organizational) it is advisable not to start with the largest industries in Burundi (BRARUDI, COTEBU) when contemplating the conversion of industrial boilers in Burundi. Instead, the most likely candidates to begin with are smaller industries such as tea factories, milk bottling factories, bakeries, etc. These are potential users of solid fuels boilers utilizing peat and thereby reducing the use of commercial (imported) fuels. In certain specific cases, peat may replace also wood as a commercial fuel, e.g. in case the factory in question has a problem locating the daily quantities of wood necessary to satisfy its energy needs, as is reported for at least one tea factory. Because the factory is close to one of the peat bogs, it would be desirable to investigate the economic and financial costs/ benefits also of such a conversion.

3. A project is therefore proposed, as a first step, to test the feasibility in a selected industry and, based on the outcome of the study and subsequent field testing, gain experience in order to decide whether conversion in other industries are warranted.

Objectives and Scope of Work

4. The objectives of the project are threefold:

   (a) determining the technical, financial, and economic feasibility of converting selected industries to boilers using peat;

   (b) field testing of a boiler system; and

   (c) establishing the total viable market for boilers of this type.

5. The activities that will be undertaken are the following:

   (a) identifying the most appropriate boiler type available on the world market, in terms of technical capabilities and financial performance;

(b) categorizing the energy needs for the secondary industries in Burundi, and matching these needs with the supply options under (a), selecting the preferred technical/financial option;

(c) selecting one industry to field test (over some months) the most appropriate boiler found under (b);

(d) determining the financial and economic feasibility of converting the selected industry to peat use, and establishing ONATOUR's capability of providing industrial users with peat; and

(e) carrying out a survey to determine the total potential market for peat conversion.

6. The project will be conducted over a ten months period by ONATOUR assisted by a team of experts who will visit Burundi for short-term missions. One industrial engineer and an economist will identify the potential market, a site for field testing, and carry out the feasibility study. A technical specialist will install and test the boiler, as well as demonstrate its use to personnel of the industry selected for field testing. The boiler will be purchased under the project and will be offered at a reduced price to the industry that took part in the field testing.

Budget

7. The total budget of the activity is estimated at US$263,500, of which the Government will contribute US$3,500.

	US$
Experts (including travel)	92,000
Design/proposal	33,000
Equipment	75,000
Testing, Miscellaneous	60,000
Local personnel and other costs	3,500
Total:	263,500

Solar Water Heater: Household Usage

1. Water needs:

Hot water use (l/d)	120	
= showers/day:	8	
Water temp:	70	°celcius
Ambient temp:	25	°celcius

2. Energy needs

Calories/month:	162.000	kcal
kWh/month:	189	kWh

3. Characteristics water heater

	Solar		Electric
Capacity (l):	90		50
Surface (m^2):	3		750
Efficiency (%):	30		85
Auxiliary electric power:	3	kW	
Average insolation:	423	cal/cm2/month	
Average hrs/day:	715	W/m2	
Capacity panel:	4,4	kWh/day	
	135	kwh/month	

4. Costs/benefits

	Solar	Electric
Equipment (US$):	1,500	400
Equipment (BUF):	240,000	65,000
Life (year):	10	10
Maintenance (BUF/yr):	2,000	2,000
Consumption (kWh/yr):	65	2,668
Electr. costs (BUF/kWh):	16	16
Electr. costs/yr (BUF):	1,040	42,700
Annualized equipm., cost (@10%):	39,100	10,500
Energy and maintenance costs/year:	3,040	44,700
Total costs/year:	42,140	55,200
Cost of water (BUF/liter):	0,96	1,26
Pay back time (yr):	4,2	
Electricity savings/year:	2,600 kWh	

Source: CEBEA, Mission.

PHOTOVOLTAIC LIGHTING SYSTEM

Data Related to One PV System

Investment/ Maintenance Requirements	Investment costs (US$)	Maintenance a/ (%)	Lifetime (year)
Panel 50 W PV module (cif)	226	2%	15
1 kWh battery (local manuf.)	40	15%	2
Voltage regulator	50	2%	6
Lamps (DC fluorescent, 15 W)	54	10%	5
Lamps (DC incandescent, 4x12 W)	0	5%	1
Wiring, switches	22	5%	6
Installation labor	15	-	10
Transport	10	-	10
Overhead service center	40	-	10
Installation, margins (+25%)	114	-	10
Total	571		

a/ As percent of equipment costs.

Annualized costs (US$) 1/	Capital costs	Maintenance costs	Installation costs	Total	Costs (%)
PV panel	29.7	4.5		34.2	25%
Battery	23.0	6.0		29.0	22%
Regulator	11.5	1.0		12.5	9%
Lamp fluor.	14.2	5.4		19.6	15%
Wiring	5.1	1.1		6.2	5%
Switches	3.4	0.8		4.2	3%
Other			29.2	29.2	22%
Total	87.0	18.8	29.2	134.9	100%

1/ Discounted over life time, i = 10%

OUTPUT AND COSTS

Utilization of lamps	Watts hours	used/day		
- fluorescent tube 1	15	10	150	Wh/day
- fluorescent tube 2	15	4	60	"
- fluorescent tube 3	15	2	30	"
Total			240	Wh/day
Total			88	kWh/year
- light output			8,400	lmh/day
- light output			3,066	klmh/year

Costs per 100 klmh	US$44.0
Costs per kWh-el	US$1.54

Assumptions: - Luminous efficiency: 50 Lm/W fluorescent
10 Lm/W incandescent
- Costs in 1989 international prices.

DATA RELATED TO 1-4 PV SYSTEMS

Output Costs		Number of Systems			
		1	2	3	4
Equipment costs	(US$)	571	947	1518	1893
Power output	(W)	50	100	150	200
Existing equipment	(US$/yr)	-	135	219	334
Additional equipment	(US$/yr)	64.2	64.2	64.2	64.2
Wiring, lamps	(US$/yr)	22.7	0	22.7	0
Installation	(US$/yr)	29.2	9.7	9.7	9.7
Maintenance	(US$/yr)	18.8	10.5	18.8	10.5
Total	(US$/yr)	135	219	334	424
Total output	(kWh/yr)	88	175	263	350
Unit cost	(US$/kWh)	1.54	1.25	1.27	1.21

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME

COMPLETED ACTIVITIES

Country	*Activity*	*Date*	*Number*
	SUB-SAHARAN AFRICA		
Africa Regional	Anglophone Africa Household Energy Workshop	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa	08/88	087/88
	Institutional Evaluation of EGL	02/89	098/89
	Biomass Mapping Regional Workshops	05/89	--
	Francophone Household Energy Workshop	08/89	103/89
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development	03/90	112/90
	Biomass Assessment and Mapping	03/90	--
Angola	Energy Assessment	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance	10/91	142/91
Benin	Energy Assessment	06/85	5222-BEN
Botswana	Energy Assessment	09/84	4998-BT
	Pump Electrification Prefeasibility Study	01/86	047/86
	Review of Electricity Service Connection Policy	07/87	071/87
	Tuli Block Farms Electrification Study	07/87	072/87
	Household Energy Issues Study	02/88	--
	Urban Household Energy Strategy Study	05/91	132/91
Burkina Faso	Energy Assessment	01/86	5730-BUR
	Technical Assistance Program	03/86	052/86
	Urban Household Energy Strategy Study	06/91	134/91
Burundi	Energy Assessment	06/82	3778-BU
	Petroleum Supply Management	01/84	012/84
	Status Report	02/84	011/84
	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987)	05/85	036/85
	Improved Charcoal Cookstove Strategy	09/85	042/85
	Peat Utilization Project	11/85	046/85
Cape Verde	Energy Assessment	08/84	5073-CV
	Household Energy Strategy Study	02/90	110/90
Comoros	Energy Assessment	01/88	7104-COM
Congo	Energy Assessment	01/88	6420-COB
	Power Development Plan	03/90	106/90
Côte d'Ivoire	Energy Assessment	04/85	5250-IVC
	Improved Biomass Utilization	04/87	069/87
	Power System Efficiency Study	12/87	--
Ethiopia	Energy Assessment	07/84	4741-ET
	Power System Efficiency Study	10/85	045/85
	Agricultural Residue Briquetting Pilot Project	12/86	062/86
	Bagasse Study	12/86	063/86
	Cooking Efficiency Project	12/87	--
Gabon	Energy Assessment	07/88	6915-GA

Country	*Activity*	*Date*	*Number*
The Gambia	Energy Assessment	11/83	4743-GM
	Solar Water Heating Retrofit Project	02/85	030/85
	Solar Photovoltaic Applications	03/85	032/85
	Petroleum Supply Management Assistance	04/85	035/85
Ghana	Energy Assessment	11/86	6234-GH
	Energy Rationalization in the Industrial Sector	06/88	084/88
	Sawmill Residues Utilization Study	11/88	074/87
Guinea	Energy Assessment	11/86	6137-GUI
Guinea-Bissau	Energy Assessment	08/84	5083-GUB
	Recommended Technical Assistance Projects	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment	05/82	3800-KE
	Power System Efficiency Study	03/84	014/84
	Status Report	05/84	016/84
	Coal Conversion Action Plan	02/87	--
	Solar Water Heating Study	02/87	066/87
	Peri-Urban Woodfuel Development	10/87	076/87
	Power Master Plan	11/87	--
Lesotho	Energy Assessment	01/84	4676-LSO
Liberia	Energy Assessment	12/84	5279-LBR
	Recommended Technical Assistance Projects	06/85	038/85
	Power System Efficiency Study	12/87	081/87
Madagascar	Energy Assessment	01/87	5700-MAG
	Power System Efficiency Study	12/87	075/87
Malawi	Energy Assessment	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry	11/83	009/83
	Status Report	01/84	013/84
Mali	Energy Assessment (French)	11/91	8423-MLI
Islamic Republic of Mauritania	Energy Assessment	04/85	5224-MAU
	Household Energy Strategy Study	07/90	123/90
Mauritius	Energy Assessment	12/81	3510-MAS
	Status Report	10/83	008/83
	Power System Efficiency Audit	05/87	070/87
	Bagasse Power Potential	10/87	077/87
Mozambique	Energy Assessment	01/87	6128-MOZ
	Household Electricity Utilization Study	03/90	113/90
Niger	Energy Assessment	05/84	4642-NIR
	Status Report	02/86	051/86
	Improved Stoves Project	12/87	080/87
	Household Energy Conservation and Substitution	01/88	082/88
Nigeria	Energy Assessment	08/83	4440-UNI
Rwanda	Energy Assessment	06/82	3779-RW
	Energy Assessment (English and French)	07/91	8017-RW
	Status Report	05/84	017/84
	Improved Charcoal Cookstove Strategy	08/86	059/86
	Improved Charcoal Production Techniques	02/87	065/87

Country	*Activity*	*Date*	*Number*
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis	11/91	--
Sao Tome and Principe	Energy Assessment	10/85	5803-STP
Senegal	Energy Assessment	07/83	4182-SE
	Status Report	10/84	025/84
	Industrial Energy Conservation Study	05/85	037/85
	Preparatory Assistance for Dono. Meeting	04/86	056/86
	Urban Household Energy Strategy	02/89	096/89
Seychelles	Energy Assessment	01/84	4693-SEY
	Electric Power System Efficiency Study	08/84	021/84
Sierra Leone	Energy Assessment	10/87	6597-SL
Somalia	Energy Assessment	12/85	5796-SO
Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment	07/83	4511-SU
	Power System Efficiency Study	06/84	018/84
	Status Report	11/84	026/84
	Wood Energy/Forestry Feasibility	07/87	073/87
Swaziland	Energy Assessment	02/87	6262-SW
Tanzania	Energy Assessment	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study	08/88	086/88
	Tobacco Curing Efficiency Study	05/89	102/89
	Remote Sensing and Mapping of Woodlands	06/90	--
	Industrial Energy Efficiency Technical Assistance	08/90	122/90
Togo	Energy Assessment	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake	04/86	055/86
	Power Efficiency Improvement	12/87	078/87
Uganda	Energy Assessment	07/83	4453-UG
	Status Report	08/84	020/84
	Institutional Review of the Energy Sector	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry	02/86	049/86
	Fuelwood/Forestry Feasibility Study	03/86	053/86
	Power System Efficiency Study	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry	02/89	097/89
	Tobacco Curing Pilot Project	03/89	UNDP Terminal Report
Zaire	Energy Assessment	05/86	5837-ZR
Zambia	Energy Assessment	01/83	4110-ZA
	Status Report	08/85	039/85
	Energy Sector Institutional Review	11/86	060/86
	Power Subsector Efficiency Study	02/89	093/88
	Energy Strategy Study	02/89	094/88
	Urban Household Energy Strategy Study	08/90	121/90
Zimbabwe	Energy Assessment	06/82	3765-ZIM
	Power System Efficiency Study	06/83	005/83
	Status Report	08/84	019/84
	Power Sector Management Assistance Project	04/85	034/85
	Petroleum Management Assistance	12/89	109/89
	Power Sector Management Institution Building	09/89	--
	Charcoal Utilization Prefeasibility Study	06/90	119/90
	Integrated Energy Strategy Evaluation	01/92	8768-ZIM

Country	*Activity*	*Date*	*Number*
	ASIA AND THE PACIFIC		
Asia Regional	Pacific Household and Rural Energy Seminar	11/90	--
Bangladesh	Energy Assessment	10/82	3873-BD
	Priority Investment Program	05/83	002/83
	Status Report	04/84	015/84
	Power System Efficiency Study	02/85	031/85
	Small Scale Uses of Gas Prefeasibility Study	12/88	--
China	County-Level Rural Energy Assessments	05/89	101/89
	Fuelwood Forestry Preinvestment Study	12/89	105/89
Fiji	Energy Assessment	06/83	4462-FIJ
India	Opportunities for Commercialization of Nonconventional Energy Systems	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project	05/91	120/91
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III	07/91	139/91
Indonesia	Energy Assessment	11/81	3543-IND
	Status Report	09/84	022/84
	Power Generation Efficiency Study	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries	04/87	067/87
	Diesel Generating Plant Efficiency Study	12/88	095/88
	Urban Household Energy Strategy Study	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II	12/90	124/90
Malaysia	Sabah Power System Efficiency Study	03/87	068/87
	Gas Utilization Study	09/91	9645-MA
Myanmar	Energy Assessment	06/85	5416-BA
Nepal	Energy Assessment	08/83	4474-NEP
	Status Report	01/85	028/84
Papua New Guinea	Energy Assessment	06/82	3882-PNG
	Status Report	07/83	006/83
	Energy Strategy Paper	--	--
	Institutional Review in the Energy Sector	10/84	023/84
	Power Tariff Study	10/84	024/84
Solomon Islands	Energy Assessment	06/83	4404-SOL
South Pacific	Petroleum Transport in the South Pacific	05/86	--
Sri Lanka	Energy Assessment	05/82	3792-CE
	Power System Loss Reduction Study	07/83	007/83
	Status Report	01/84	010/84
	Industrial Energy Conservation Study	03/86	054/86
Thailand	Energy Assessment	09/85	5793-TH
	Rural Energy Issues and Options	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study	02/88	083/88
	Impact of Lower Oil Prices	08/88	--
	Coal Development and Utilization Study	10/89	--
Tonga	Energy Assessment	06/85	5498-TON
Vanuatu	Energy Assessment	06/85	5577-VA
Western Samoa	Energy Assessment	06/85	5497-WSO

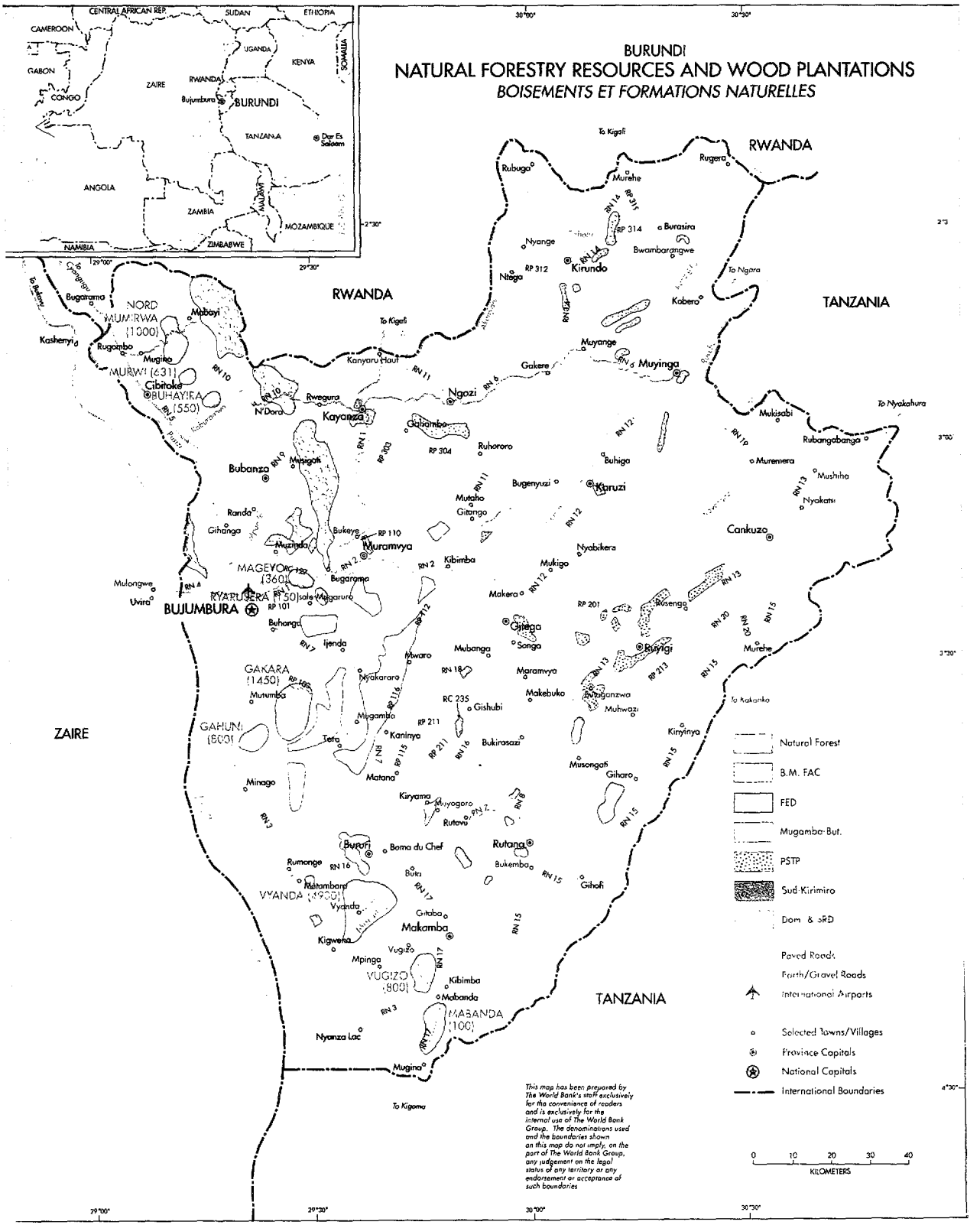
Country	*Activity*	*Date*	*Number*
	EUROPE, MIDDLE EAST AND NORTH AFRICA (EMENA)		
Morocco	Energy Assessment	03/84	4157-MOR
	Status Report	01/86	048/86
Pakistan	Household Energy Assessment	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets	10/89	103/89
Portugal	Energy Assessment	04/84	4824-PO
Syria	Energy Assessment	05/86	5822-SYR
	Electric Power Efficiency Study	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector	06/90	115/90
Tunisia	Fuel Substitution	03/90	--
Turkey	Energy Assessment	03/83	3877-TU
Yemen	Energy Assessment	12/84	4892-YAR
	Energy Investment Priorities	02/87	6376-YAR
	Household Energy Strategy Study Phase I	03/91	126/91
	LATIN AMERICA AND THE CARIBBEAN (LAC)		
LAC Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean	07/89	--
Bolivia	Energy Assessment	04/83	4213-BO
	National Energy Plan	12/87	--
	National Energy Plan (Spanish)	08/91	131/91
	La Paz Private Power Technical Assistance	11/90	111/90
	Natural Gas Distribution	03/91	125/91
	Prefeasibility Evaluation Rural Electrification and Demand Assessment	04/91	129/91
Chile	Energy Sector Review	08/88	7129-CH
Colombia	Energy Strategy Paper	12/86	--
Costa Rica	Energy Assessment	01/84	4655-CR
	Recommended Technical Assistance Projects	11/84	027/84
	Forest Residues Utilization Study	02/90	108/90
Dominican Republic	Energy Assessment	05/91	8234-DO
Ecuador	Energy Assessment	12/85	5865-EC
	Energy Strategy Phase I	07/88	--
	Energy Strategy	04/91	--
Haiti	Energy Assessment	06/82	3672-HA
	Status Report	08/85	041/85
Honduras	Energy Assessment	08/87	6476-HO
	Petroleum Supply Management	03/91	128/91
Jamaica	Energy Assessment	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study	11/86	061/86
	Energy Efficiency Building Code Phase I	03/88	--
	Energy Efficiency Standards and Labels Phase I	03/88	--
	Management Information System Phase I	03/88	--
	Charcoal Production Project	09/88	090/88
	FIDCO Sawmill Residues Utilization Study	09/88	088/88

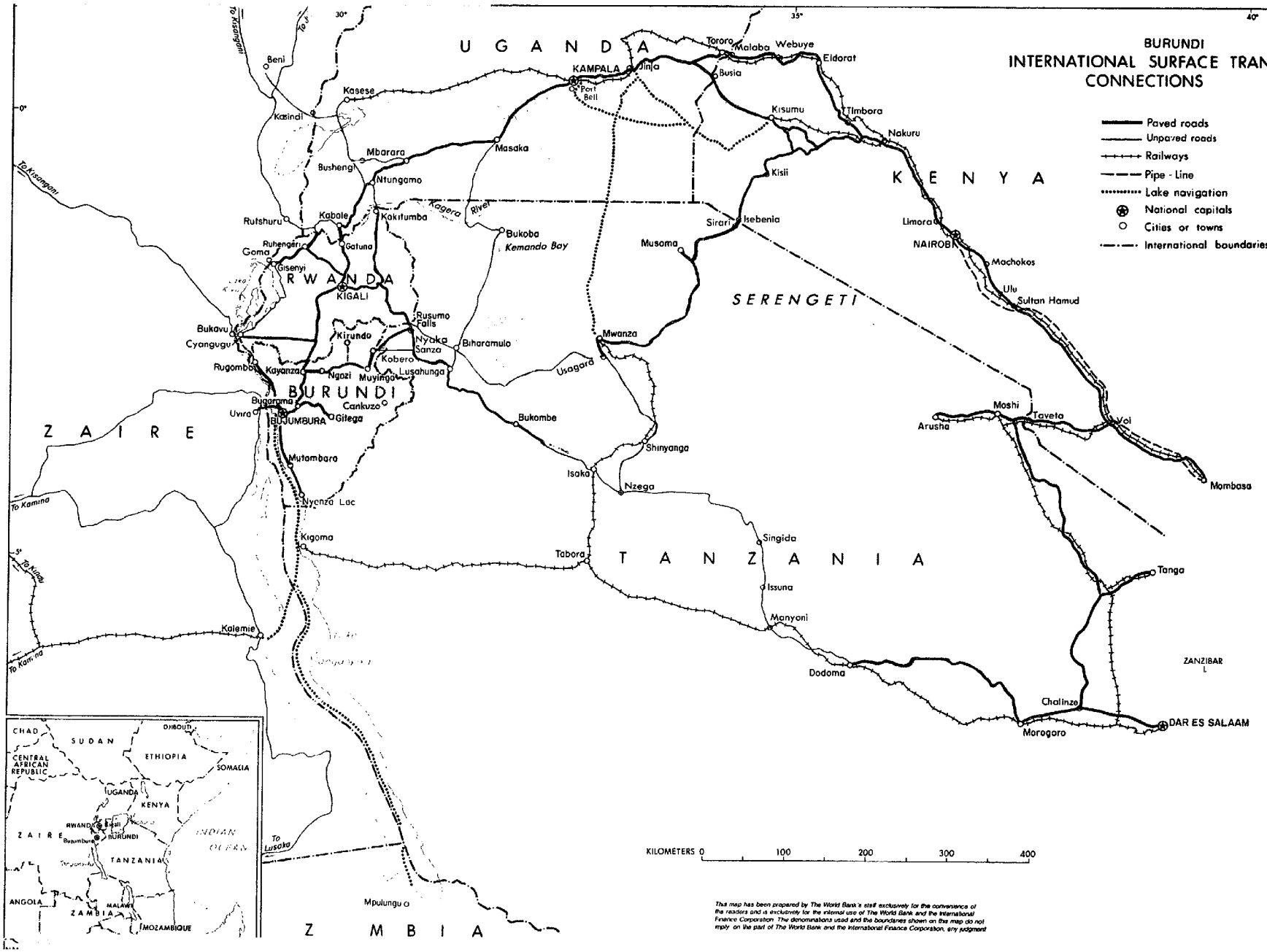
Country	*Activity*	*Date*	*Number*
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz	08/91	138/91
Panama	Power System Efficiency Study	06/83	004/83
Paraguay	Energy Assessment	10/84	5145-PA
	Recommended Technical Assistance Projects	09/85	--
	Status Report	09/85	043/85
Peru	Energy Assessment	01/84	4677-PE
	Status Report	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra	02/87	064/87
	Energy Strategy	12/90	--
Saint Lucia	Energy Assessment	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment	09/84	5103-STV
Trinidad and Tobago	Energy Assessment	12/85	5930-TR

GLOBAL

Energy End Use Efficiency: Research and Strategy	11/89	--
Guidelines for Utility Customer Management and Metering	07/91	--
Women and Energy--A Resource Guide The International Network: Policies and Experience	04/90	--
Assessment of Personal Computer Models for Energy Planning in Developing Countries	10/91	--

BURUNDI
NATURAL FORESTRY RESOURCES AND WOOD PLANTATIONS
BOISEMENTS ET FORMATIONS NATURELLES




BURUNDI
INTERNATIONAL SURFACE TRAN
CONNECTIONS
Paved roads
Unpaved roads
Railways
Pipe - Line
Lake navigation
National capitals
Cities or towns
International boundaries
UGANDA
KENYA
RWANDA
BURUNDI
TANZANIA
ZAIRE
ZAMBIA
SERENGETI
KAMPALA
Jinja
Port Bell
Tororo
Malaba
Webuye
Eldoret
Busia
Kisumu
Timbora
Nakuru
Kisii
Sirari
Isebenia
Limora
NAIROBI
Machokos
Ulu
Sultan Hamud
Musoma
Mwanza
Masaka
Mbarara
Bushenji
Ntungamo
Kasese
Kasindi
Beni
Rutshuru
Kabale
Kakitumba
Kagera River
Bukoba
Kemando Bay
Ruhengeri
Goma
Gatuna
Gisenyi
KIGALI
Rusumo Falls
Nyaka Sanza
Biharamulo
Kirundo
Kobero
Lusahunga
Muyinga
Ngozi
Kayanza
Rugombo
Bukavu
Cyangugu
Bujumbura
Uvira
Gitega
Cankuzo
Usagara
Bukombe
Shinyanga
Isaka
Nzega
Mutambara
Nyanza Lac
Kigoma
Tabora
Singida
Issuna
Manyoni
Dodoma
Kalemie
Mpulungu
Moshi
Taveta
Arusha
Voi
Mombasa
Tanga
ZANZIBAR
Chalinze
Morogoro
DAR ES SALAAM
To Kasongani
To Kisangani
To Kamina
To Kitale
To Lusaka
30°
35°
40°
0°
5°
KILOMETERS 0 100 200 300 400
CHAD
SUDAN
DJIBOUTI
CENTRAL AFRICAN REPUBLIC
ETHIOPIA
SOMALIA
UGANDA
KENYA
ZAIRE
RWANDA
BURUNDI
INDIAN OCEAN
TANZANIA
ANGOLA
ZAMBIA
MALAWI
MOZAMBIQUE
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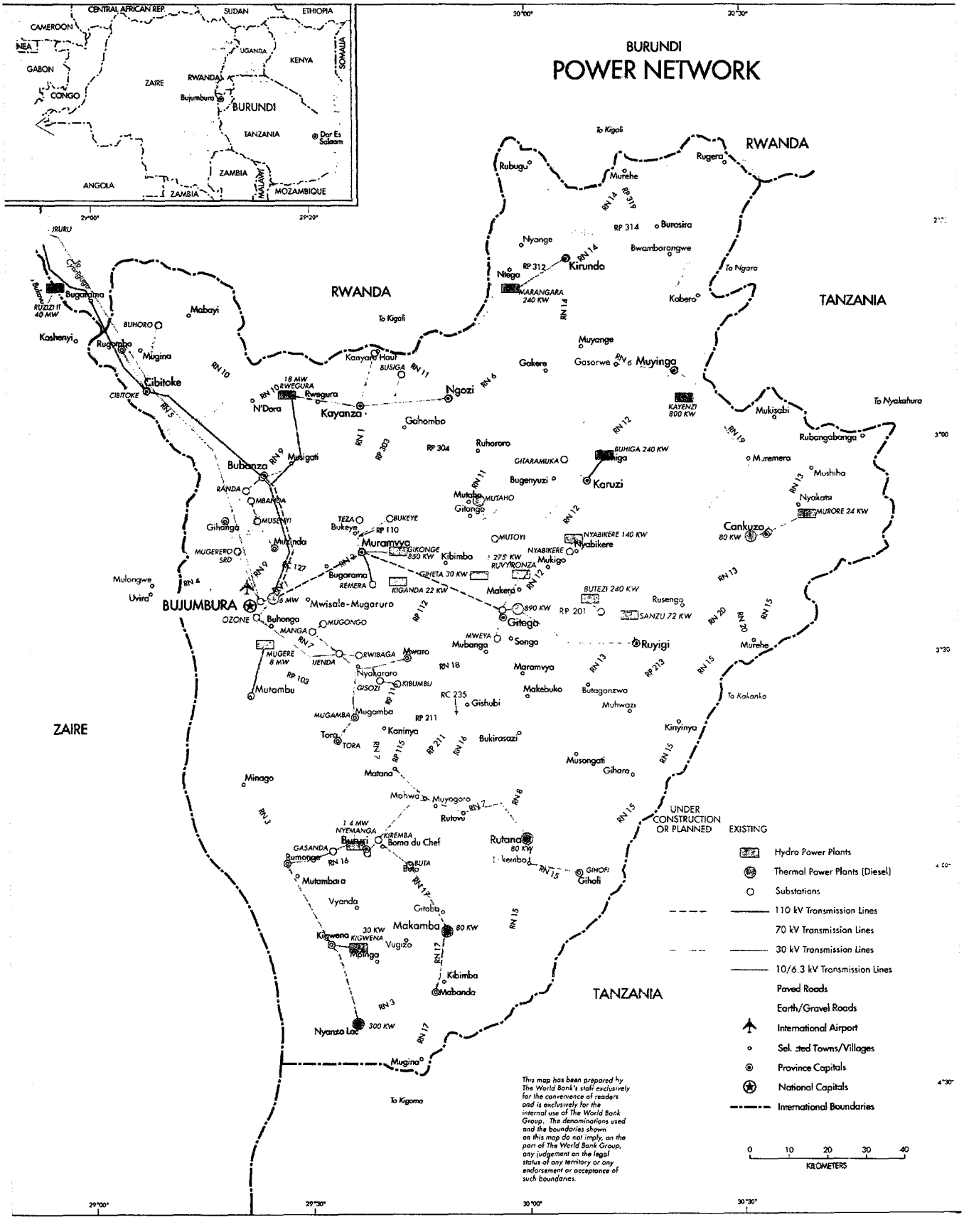
BURUNDI
POWER NETWORK
CENTRAL AFRICAN REP.
SUDAN
ETHIOPIA
CAMEROON
NEA
GABON
CONGO
ZAIRE
UGANDA
KENYA
SOMALIA
RWANDA
Bujumbura
BURUNDI
TANZANIA
Dar Es Salaam
ZAMBIA
ANGOLA
MALAWI
MOZAMBIQUE
RWANDA
TANZANIA
ZAIRE
To Kigali
To Ngara
To Nyakahura
To Kigoma
To Kakanko
To Cyangugu
Rubuga
Murehe
Rugera
RP 314
Burasira
Nyange
Bwambarangwe
Kirundo
Niega
RP 312
MARANGARA 240 KW
Kobero
Muyange
Gakere
Gasorwe
Muyinga
KAYENZI 600 KW
Mukisabi
Rubangabanga
Mabayi
BUHORO
Kashenyi
Rugombo
Mugina
Cibitoke
CIBITOKE
Bugarama
RUZIZI II 40 MW
18 MW RWEGURA
Rwegura
N'Dora
Kayanza
Kanyaru Haut
BUSIGA
Ngozi
Gahombo
Ruhororo
RP 304
RP 303
BUHIGA 240 KW
GITARAMUKA
Bugenyuzi
Karuzi
Mutaho
MUTAHO
Gitango
Bubanza
Musigati
RANDA
MBANDA
MUSENYI
Gihanga
Mutinda
MUGERERO SRD
TEZA
BUKEYE
Bukeye
RP 110
Muramvya
GIKONGE 850 KW
Kibimba
MUTOYI
NYABIKERE 140 KW
Nyabikere
NYABIKERE
275 KW RUVYRONZA
Mukigo
GIHETA 30 KW
Bugarama
REMERA
KIGANDA 22 KW
Makera
BUTEZI 240 KW
Rusenga
RP 201
SANZU 72 KW
Cankuzo
80 KW
MURORE 24 KW
Nyakatsi
Mushiha
Mulongwe
Uvira
BUJUMBURA
6 MW
Mwisale-Mugaruro
OZONE
Buhonga
MANGA
MUGONGO
890 KW
Gitega
MWEYA
Songo
Mubanga
Ruyigi
Murehe
MUGERE 8 MW
MENDA
RWIBAGA
Mwaro
Nyakararo
GISOZI
KIBUMBU
Mutambu
RC 235
Gishubi
Maramvya
Makebuko
Butagonzwa
Muhwazi
MUGAMBA
Mugamba
Kanimya
Tora
TORA
Bukirasazi
Kinyinya
Musongati
Gihara
Matana
Minago
Mahwa
Muyogoro
Rutovu
Rutana
80 KW
Kiremba
Boma du Chef
1.4 MW NYEMANGA
Bururi
GASANDA
Rumonge
BUTA
Buta
Mutambara
Vyanda
Gitaba
Makamba
80 KW
30 KW KIGWENA
Kigwena
Vugizo
Mbinga
Kibimba
Mabanda
Nyanza Lac
300 KW
Mugina
Gihofi
GIHOFI
UNDER CONSTRUCTION OR PLANNED
EXISTING
Hydro Power Plants
Thermal Power Plants (Diesel)
Substations
110 kV Transmission Lines
70 kV Transmission Lines
30 kV Transmission Lines
10/6.3 kV Transmission Lines
Paved Roads
Earth/Gravel Roads
International Airport
Sel. ted Towns/Villages
Province Capitals
National Capitals
International Boundaries
0 10 20 30 40
KILOMETERS
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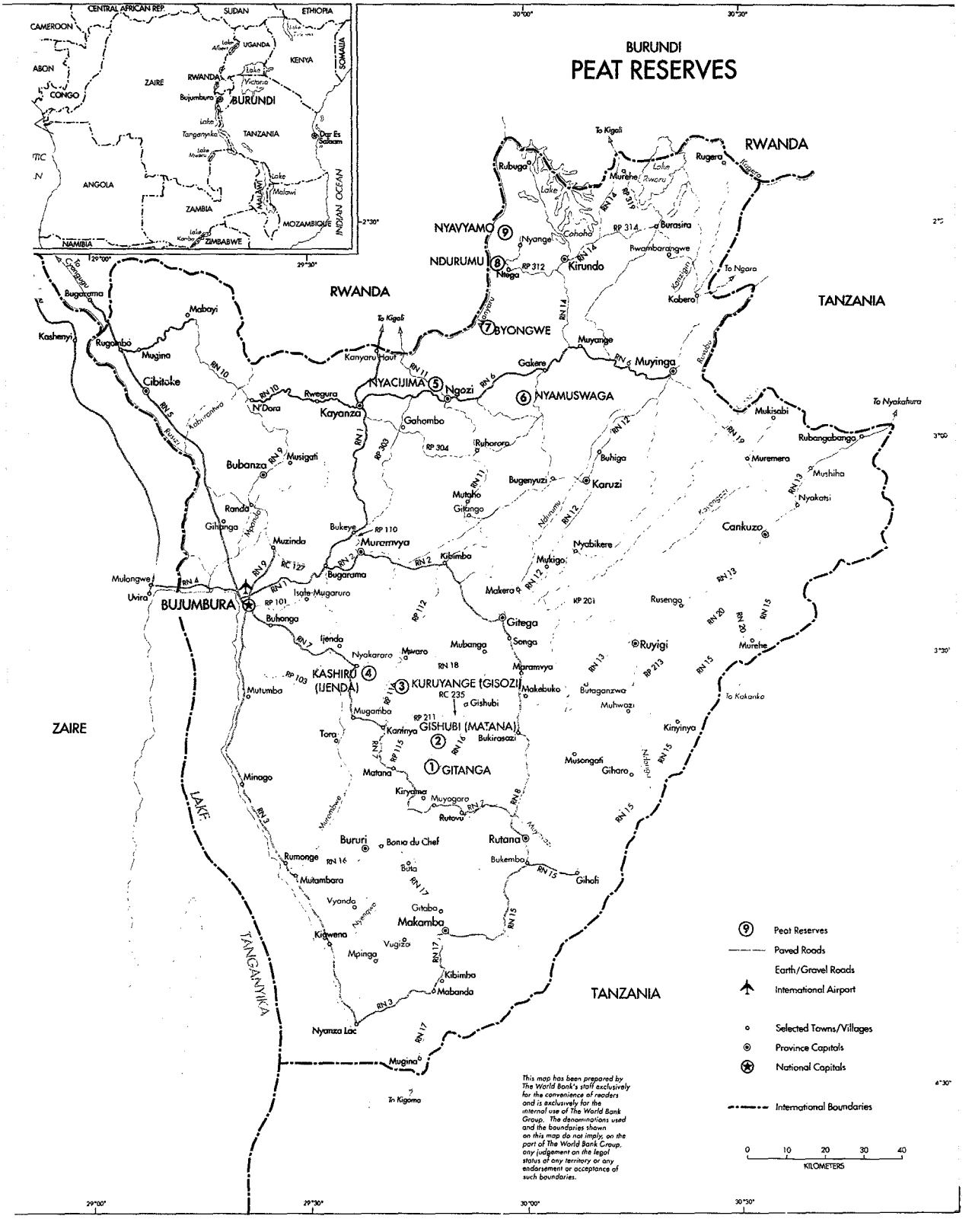
BURUNDI
PEAT RESERVES
CENTRAL AFRICAN REP.
SUDAN
ETHIOPIA
CAMEROON
UGANDA
KENYA
SOMALIA
GABON
CONGO
ZAIRE
RWANDA
BURUNDI
TANZANIA
ANGOLA
ZAMBIA
MALAWI
MOZAMBIQUE
ZIMBABWE
NAMIBIA
INDIAN OCEAN
Lake Victoria
Lake Tanganyika
Lake Malawi
Bujumbura
Dar Es Salaam
RWANDA
TANZANIA
ZAIRE
LAKE TANGANYIKA
NYAVYAMO 9
NDURUMU 8
BYONGWE 7
NYACIJIMA 5
NYAMUSWAGA 6
KASHIRU (IJENDA) 4
KURUYANGE (GISOZI) 3
GISHUBI (MATANA) 2
GITANGA 1
BUJUMBURA
Kirundo
Muyinga
Ngozi
Kayanza
Muramvya
Gitega
Ruyigi
Karuzi
Bubanza
Cibitoke
Bururi
Rutana
Makamba
Cankuzo
Kabarore
Kobero
Rugera
Rubuga
Murehe
Burasira
Kayanza
Kirundo
Muyinga
Ngozi
Muramvya
Gitega
Ruyigi
Bujumbura
Bubanza
Cibitoke
Bururi
Rutana
Makamba
Cankuzo
To Kigali
To Ngara
To Nyakahura
To Kakanko
To Kigoma
Nyanza Lac
Mugina
Mabanda
Kibimba
Gihofi
Bukemba
Bururi
Rumonge
Mutambara
Vyanda
Gitabo
Kigwena
Mpinga
Vugizo
Muyogoro
Rutovu
Kiryama
Matana
Minago
Mutumba
Tora
Mugamba
Kanyinya
Bukirasazi
Musongati
Gitaro
Kinyinya
Makebuko
Butaganzwa
Muhwazi
Songa
Mubanga
Mwaro
Nyakararo
Ijenda
Buhonga
Isale-Mugaruro
Bugarama
Uvira
Mulongwe
Muramvya
Bukeye
Muzinda
Randa
Gitanga
Musigati
Bubanza
Kayanza
Rwegura
N'Dora
Mugina
Mabayi
Bugarama
Kashenyi
Rugombo
Gahombo
Ruhororo
Bugenyuzi
Mutaho
Gitongo
Buhiga
Muyinga
Muyange
Gakere
Kanyaru Haut
Nyange
Cohoha
Rubuga
Murehe
Rugera
Burasira
Rwambarangwe
Kabarore
Mukisabi
Rubangabanga
Muremera
Mushiha
Nyakatsi
Nyabikere
Mukigo
Makero
Rusenga
Kibimba
Gishubi
Muyogoro
Rutovu
Bonia du Chef
Buta
Bukemba
Gihofi
Muyogoro
Muyogoro
Peat Reserves
Paved Roads
Earth/Gravel Roads
International Airport
Selected Towns/Villages
Province Capitals
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International Boundaries
0 10 20 30 40
KILOMETERS
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