Burkina Faso

Urban Household Energy Strategy

Report No. 134/91

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 Progamme which had been established three years earlier. An international Commission was convened in 1990 to address the creation of ESMAP's role in the Nineties. It concluded that the Programme had a crucial part to play over the next decade in assisting the developing countries to better manage their energy sectors given that the supply of energy at reasonable prices is a critical determinant of the pace and magnitude of the growth process. The Commission's recommendations received broad endorsement at the November 1990 ESMAP Annual Meeting. Today, ESMAP is carrying out energy assessments, preinvestment and prefeasibility activities and is providing institutional and policy advice. The program aims to strengthen the impact of bilateral and multilateral resources and private sector investment through providing technical assistance to the energy sector of developing countries. The findings and recommendations emerging from ESMAP activities provide governments, donors, and potential investors with the information needed to identify economically and environmentally sound energy projects and to accelerate their preparation and implementation.

ESMAP's operational activities are managed by two Divisions within the Industry and Energy Department at the World Bank and an ESMAP Secretariat.

- The Programme's activities are governed by the ESMAP Consultative Group which consists of its co-sponsors, the UNDP and the World Bank, the governments which provide financial support and representatives of the recipients of its assistance. The Chairman of the Group is the World Bank's Vice President, Sector Policy and Research. He is assisted by a Secretariat headed by the Group's Executive Secretary who is also responsible for relations with the donors and securing funding for the Programme's activities. The Secretariat also gives support and advice to a Technical Advisory Group of independent energy experts which meets periodically to review and scrutinize the Programme's strategic agenda, its work program and other issues related to ESMAP's functioning.

- The ESMAP Strategy and Programs Division is responsible for advising on which countries should receive ESMAP assistance, preparing relevant ESMAP programs of technical assistance to these countries and supports the Secretariat on funding issues. It also carries out broadly based studies such as energy assessments.

- The ESMAP Operations Division is responsible for the detailed design and implementation of tasks consisting mainly of sub-sectoral strategy formulation, preinvestment work, institutional studies, technical assistance and training within the framework of overall ESMAP country assistance programs.

FUNDING

The ESMAP represents a cooperative international effort supported by the World Bank, the United Nations Development Programme and other United Nations agencies, the European Community, Organization of American States (OAS), Latin American Energy Organization (OLADE), and a number of 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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BURKINA FASO

URBAN HOUSEHOLD ENERGY STRATEGY

JUNE 1991

EXCHANGE RATE

US$ = CFA Francs 300

CONVERSION FACTORS USED

General Units

1 ton crude oil equivalent (TOE) = approximately 42 GJ
1 kWh = 3.6 MJ

Fuel	Ton/m^3	MJ/kg
Charcoal	-	29.0
LPG	-	45.7
Kerosene	0.79	43.5

Fuelwood Volume and Weight Units

1.0 m^3	3.2	stères
1.0 stère	0.31	m^3
1.0 m^3	0.80	tons (density)
1.0 stère	250.0	kg
4.0 stères	1.0	ton
1.0 stère	36.0	standard bundles

Standing Volume of Commercial Fuelwood

For unmanaged natural savannah forest, 60% of the total volume is in commercial fuelwood species of usable diameter.

For managed natural savannah forest, 80% of the total volume is assumed to be in commercial species of usable diameter.

ABBREVIATIONS AND ACRONYMS

CAPRO	Ministry of Commerce
DSVF	MET Extension Service
ESMAP	Energy Sector Management Assistance Program
FAO	Food and Agriculture Organization
IBE	Burkinabe Institute for Energy
MAE	Ministry of Agriculture
MEFSN	Family Ministry
MESRS	Ministry of Higher Education and Scientific Research
MET	Ministry of Environment and Tourism
SONAHBY	Burkinabe Oil Company
TOE	Ton of oil equivalent

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EXECUTIVE SUMMARY

1. This report addresses the accelerating demand for woodfuels as an energy source for Burkina Faso's urban households and its impact on the country's natural resource endowment. It sets out an urban household energy strategy, anchored in Government's on-going efforts, that aims to slow current fuelwood consumption and promote a broader scale substitution of alternative fuels than is presently the case. This strategy is the result of a collaborative venture, begun in 1987, between the Government of Burkina Faso and the joint UNDP/World Bank Energy Sector Management Assistance Program (ESMAP). It was co-financed by the Governments of Norway and the Netherlands.

Energy and Environment

2. Energy policy is a critical instrument of environmental management for Burkina Faso, which has no known hydrocarbon resources. Fuelwood is the principal source of energy and the household sector its most important fuelwood consumer, accounting for 3 million tons per annum, 98% of household primary energy demand, and 89% of final energy demand. The informal sector represented as much as 20% of total urban woodfuel consumption, where demand is concentrated in a few energy intensive activities: the informal sector beer brewers, consisting largely of women, account for about 12% of total urban fuelwood consumption and about 60% of informal sector fuelwood consumption. Biomass is the most prevalent energy source even in industry, where consumption is three times as high as that of oil-based products.

3. Burkina's overall energy consumption in 1987 of 1.45 million tons oil equivalent is one of the world's lowest, expressed in terms of per capita energy consumption (160 kg of oil equivalent); in terms of per capita consumption of oil products (17 kg); or in terms of per capita consumption of electricity (14 kWh). Yet even the satisfaction of this low level of demand for oil products represents a very real challenge to policymakers. In 1987, the cost of importing 130,000 tons of oil products amounted to US$ 47 million, or 16% of export income and 6.5% of total imports of goods and services. In light of these costs and competing development priorities for scarce resources, the transition from biomass to modern fuels, which is in process, requires careful management. Indeed, the key energy issue facing the country is how to achieve an ecologically sustainable balance between fuelwood demand and fuelwood supply with minimal consequences on oil imports.

4. An array of obstacles constrain Burkina's development prospects, with widespread poverty and rapid demographic growth posing the greatest challenge. They are the principal causes of the persistent erosion of natural resources. A total population of 9.8 million in 1989 is projected to double over the next twenty years and reach 13.8 million by the year 2000. Although the urban population represented no more than 11% of the total population in 1989, the urban sector is a significant feature of national economic growth, accounting for an average 68% of GDP (constant 1979 prices) from 1982-1987. Urban economic growth -- and its claim on natural resources to fuel that growth -- is expected to be further enhanced in the future. The urban population is growing at about 8% a year, more than double the overall rate of population growth. By the end of the century, the urban share will climb to 21% of the total population of 13.8 million, or 2.9 million.

5. Woodfuels will continue to be the main energy source for the majority of Burkina Faso's population in the future. National woodfuel consumption will rise from 3 million tons in 1988 to 4.5 million tons in 2000 and urban fuelwood consumption from .33 million tons to 0.90 million tons. At the same time, this report estimates that the forest cover is presently decreasing at about 60,000 hectares per year: land clearing for agricultural development accounts for about 40,000 hectares, while the remainder is the result of bushfires, drought and the cutting of wood for fuelwood consumption in mostly unmanaged natural forests.

6. Total natural wood production is currently estimated to be about 10 million m3 (6-7 million tons) per year. The Ministry of Environment and Tourism (MET) estimates that, of the total woodfuel demand of 3 million tons per annum, 2.5 million tons are available for fuelwood consumption in the sense of being accessible to the local population and corresponding to local demand. In 1987, the deficit of 0.5 million tons, representing the difference between demand and presently sustainable supply, was met by clearing of the forest cover (cutting of green or remaining dead wood). How much of this is a by-product of agricultural land clearing and how much is due to the rapid growth in the urban demand for biomass is unknown.

Government Policy

7. Government acknowledged the importance of natural resource management to economic development in a far reaching forest protection program, "Les Trois Luttes", which was set in motion in 1985 to reduce the impact of bush fires, uncontrolled grazing and overcutting of fuelwood on its natural environment. The Government implemented a household energy strategy with complementary actions in the areas of (a) demand reduction, (b) fuel switching and (c) fuelwood supply management. This strategy can be characterized as follows:

(i) The demand management effort was anchored in the dissemination of improved woodstoves and the promotion of LPG and kerosene. The supply management initiatives centered around a change in the fuelwood price structure in favor of fuelwood producer and the creation of woodcutters cooperatives.

(ii) Pricing policy is an important policy instrument of this program: For budgetary reasons, no subsidies are given to the fuelwood substitute fuels LPG and kerosene. Instead, the Government increased the prices of woodfuels by raising both cutting fees and producer prices in the official price structure and by reorganizing the transport sector.

(iii) To achieve policy objectives, the program relies heavily on the public sector with a high degree of Government involvement not only in supportive research and training but also in operational activities and a reliance on political rather than commercial messages in promotion campaigns.

Program Results

8. The 1990 targets for household energy policy in the 1986-1990 Development Plan were to: (a) have two-thirds of all households using an improved fuelwood stove, (b) have 32,000 households using an LPG stove and to reach an annual LPG consumption of 4,800 tons, (c) market LPG and kerosene stoves for the urban population and (d) protect and regenerate the wood resources. Important lessons have been learned by this program, which is one of Sub-Saharan Africa's most ambitious efforts. Over 100,000 improved stoves were constructed by the rural population and public awareness of the importance of environmental conservation was raised. At the same time, however, the preservation of the forest cover is not an immediate concern of poor rural households and, as a consequence, they did not attach high priority to these energy saving measures. In addition, the relatively good access to fuelwood, as perceived by many women who collect it, provides little incentive to reduce consumption, further undermining the objectives of the program. The lackluster penetration of improved stoves in rural households is ample evidence; a 70% penetration rate of improved stoves drops to less than half of that level after the first year.

9. **On the stove production side**, the Burkinabe Institute for Energy (IBE) has made good progress in developing a wide array of different stove models for household and informal sector use. Nonetheless, efforts to mobilize local artisans to produce improved stoves have not had the desired results, due to excessive Government interference in distribution and marketing activities and modest demand for the product. In 1987, about one-third of all urban households were using an improved woodstove (50% Plan fulfillment), although it was but **one** of several cooking devices in use. Almost 60% of urban households continue to use the **traditional 3-stone stove** exclusively. The pace of **sales of improved woodstoves** (6,000-7,000 per annum) since 1987 has been below that needed for stove replacement and to keep up with the growth of the urban population. The annual formation of about 12,000 new urban households, representing 23,000 additional tons of firewood per annum, wiped out the already meager fuelwood savings (15,000 tons per annum) claimed by the program. The response of very poor Burkinabe families to the improved stove program has been especially disappointing: Of households with monthly incomes below 20,000 CFAF, only 18% had acquired an **improved 3-stone stove** and only 5% an improved metal stove.

10. Efforts on the **supply side** in favor of reforestation produced modest results. Industrial plantations have not proved cost-effective for fuelwood production. Similarly, organization and implementation of village afforestation schemes have been extremely difficult. Thorny issues including those of land tenure, traditional patterns of cultivation, village politics, internal migration trends, to mention but a few, further complicated an extremely complex issue. The introduction of techniques to manage natural forests and degraded woodlands promises to be the most cost effective means of promoting sustainable production methods. These efforts are, however, still in their early stages. Government has paved the way for this initiative by adopting a new price structure for fuelwood, which provides more adequate margins for fuelwood producers, and by encouraging the establishment of woodcutters' cooperatives. These cooperatives represent an important first step in rationalizing the fuelwood supply chain but sustainable management of forest and tree resources will require that these woodcutters' cooperatives evolve into woodland management entities with clearly defined rights and obligations vis-a-vis land tenure; pricing; cost recovery; multi-purpose land uses, etc. A recent FAO-assisted pilot project in natural forest

management in the national forest at Nazinon, within the Ouagadougou fuelwood supply zone, is beginning to provide positive results. It will, however, require testing on a much larger scale and a careful evaluation of the incentive environment needed to mobilize across-the-board popular participation that will be essential to the success of this program.

11. On the positive side, pricing policy showed its strength. Following a reorganization of the fuelwood supply structure in 1985, fuelwood prices had climbed by 60% in Ouagadougou with household demand dropping to a level that was, on average, 9% lower than average fuelwood demand in the three other major cities.

12. The Government, through SONABHY, the national oil company, has made important investments in infrastructure by, inter alia, setting up LPG bottling plants in Ouagadougou and in Bobo-Dioulasso. Notwithstanding these efforts, inter-fuel substitution activities have been hampered by the high cost of moderns fuels, the inadequacy of stove equipment, the widespread skepticism about their safety and convenience, and lack of coordination between SONABHY, the importer and bottling operator; the private oil companies, responsible for distribution; and IBE, responsible for development of appropriate kerosene and LPG stoves. Both kerosene and LPG find their use mainly as supplementary sources of energy for cooking. In 1987, approximately 9% of households in the four major cities had acquired an LPG stove (one-third Plan fulfillment) and total demand for LPG had increased from 745 tons in 1985 to 1,476 tons in 1987. Since then, demand has stagnated; LPG demand in Burkinabe households is no higher than 700 tons, equivalent to a replacement of no more than 4,000-5,000 tons of fuelwood per annum. In 1987, kerosene stoves were found in about 4% of urban households and urban household kerosene consumption amounted to approximately 3,500 tons, of which 94% was used for lighting, 2% for cooking and water heating, and 4% for other uses.

Need for New Directions

13. It is difficult to identify any dynamic forces that, during the 1990s, could reverse the stagnation of Government's energy savings and fuelwood substitution program. The expected rise in per capita income is too low, by itself, to accelerate fuelwood substitution. Moreover, the standing volume of wood is still sufficiently large to meet the rising demand for fuelwood with little or no upward pressure on prices. Without a fine-tuning of current policies--shifting emphasis and expanding their scope, it is unlikely that progress will be achieved beyond present levels. Government's household energy strategy has the necessary components - promotion of fuel savings, fuelwood substitution, fuelwood supply management. Critical to the success of Government efforts over the longer term is an assessment of (a) the effectiveness of the mode of implementation of the components, (b) the adequacy of the legal and institutional framework and (c) the rationale of Government pricing policies.

14. Even with forestry management plans and with current population projections, a more widespread shift to substitute fuels in the urban centers will become a necessity early into the next century. At that time, urban fuelwood demand will have reached its sustainable plateau and LPG and kerosene will have to meet the household energy requirements of the total increase in urban population. To do so, LPG and kerosene consumers must use these fuels as their primary

energy source for cooking and heating. During the 1990's, inter-fuel substitution initiatives must prepare for the future by acquainting households that do not use modern fuels with their advantages. The number of LPG and kerosene consuming households which, in the year 2000, will total approximately 115,000, is projected to increase to 650,000 by the year 2010. Depending on the contribution of kerosene, LPG household consumption could be in the range of 7,200-8,500 tons by the year 2000, and should reach somewhere between 60,000-115,000 tons by the year 2010. While it is recognized that the switch to substitute fuels will be expensive, the price of substitution, which is inevitable in light of current population trends, will be even higher if Government continues on its present course. Under any scenario, and given the country's development constraints, the reality is that, early in the next century, energy for all will be more expensive.

Key Policy Recommendations and Conclusions of the ESMAP/MET Study

Redefining Government's Role.

15. The high degree of direct Government involvement in the household energy sector during the 1980s helped to achieve some important short term results, although still far short of the program's objectives. Yet, the present stagnation demonstrates that long-term progress will depend on a redefinition of the balance between the use of direct Government intervention and the use of policy tools that use the market mechanism to achieve the desired objectives. Two principles should shape this balance: (i) Government intervention is justified only where market failures block the achievement of program objectives; (ii) Where such circumstances exist, and where legal and/or institutional obstacles are the principal impediments, it should be determined whether their removal would be more cost-efficient than direct Government intervention. As a general rule, the Government should be responsible for guiding policy and shaping public awareness, supporting energy R&D, securing funding for information and education campaigns and monitoring progress. Private entities and NGO's should have primary responsibility for implementing the components of the strategy.

Shift of Attention to Urban Fuelwood Needs

16. In the past, Government's efforts have been heavily anchored in promoting improved stoves in the rural areas; in 1987, emphasis began to shift to the urban sector. The justification for the rural improved stove program lies in the fact that present rural fuelwood consumption is eight times as high as urban fuelwood consumption and will still be four times as high in the year 2000. However, because the rural population tends to meet its fuelwood requirements from dead wood, the impact on the environment is not as large as that due to clearfelling for agricultural development. The rapidly growing urban sector poses a far more serious problem for the management of these natural resources and must become the prime focus of future efforts. While up to the year 2000, the rural sector will account for 60% of the increase in fuelwood demand, the pace of urban growth will change this scenario thereafter: towards 2010, the urban sector will account for almost 80% of the increase in fuelwood consumption. Thus, while present efforts in the rural sector should be continued, any increase in effort should be directed towards the urban areas only.

17. The concentrated urban fuelwood demand contributes directly to environmental degradation, since a rising share of this natural resource is mined exclusively for the urban market. Because these mined areas are not used for agricultural purposes and are unprotected from wind and rain, soil degradation is most severe and the regenerative capacity of the tree cover is lost. The impact of this demand is already visible around the larger urban centers where soil erosion and deforestation have affected their immediate hinterlands. Actions to restrain urban fuelwood demand must, therefore, receive clear priority and need to be directed, in the short term, to Ouagadougou on the central plateau, where the majority of urban residents live.

Fuelwood Saving

18. The highest immediate operational priority is to reinforce the fuelwood savings program, by rationalizing the urban improved stoves program and by extending its scope to include changes in consumer behavior. The benefit-cost ratio of interventions in this area is substantial and some 20 to 25% of potential demand can be cut. To achieve an 80% urban penetration rate by the year 2000, the current approach needs to shift towards a self-sustaining, non-subsidized, private sector-based activity, that uses existing commercial channels for production and marketing. The changes are needed:

(a) The MET should withdraw from direct operational involvement and discontinue public sector sales of improved stoves;

(b) The MET's role in stove promotion should be to: (i) identify and fund supportive actions in R&D in collaboration with the IBE, (ii) prepare general promotional material, (iii) assist in identifying and promoting "best practices" and (iv) monitor results.

(c) The MET should establish targets for the level of stove penetration rates for each of the five major cities and secure financing for operations. Local NGO's with relevant experience should be identified for implementation.

(d) The ad-hoc promotion campaigns should be replaced by year round promotion efforts.

(e) Promotional pricing of stoves during sales campaigns should be abandoned.

(f) A wider range of improved stove models should be marketed to capture more energy-conscious consumers, through the introduction of multi-pot stoves, a more vigorous promotion of ceramic stoves and of more expensive, attractive stoves stoves.

(g) The needs of the lowest income groups for improved fuelwood stoves need special attention to secure a broader penetration rate. Such measures could include the continued promotion, even in the urban centers, of the "improved 3-stone" stove.

(h) Production of improved stoves should continue to be based on the informal sector, since it is the lowest cost producer. To improve the incentive environment, producers should be allowed to set their own margins.

(i) Door-to-door sales of improved stoves should be promoted.

19. The informal sector must become a priority target for energy saving campaigns because of (i) the high concentration of energy consumption in a few energy intensive activities, and (ii) the commercial orientation of the fuel users. Initially, action should be focused on the informal beer ("dolo") producers, the "dolotieres" who account for 12% of urban and 60% of informal sector fuelwood consumption. IBE has developed an improved stove for "dolo" production, which, according to test results, can reduce fuelwood consumption by 30%. Once user acceptance of the stove has been established in field tests, it should be produced and promoted by an intensive campaign aimed at an 80% penetration rate within three years.

20. Promotion of energy saving habits. The potential for energy savings through changes in cooking practices is as large as that achievable through the introduction of improved stoves - some 10 - 20% of domestic fuel consumption. The MET, in collaboration with the IBE and the Ministry of Social Affairs, should (a) implement information campaigns directed at households to promote energy saving habits, e.g. use of a lid; protection from wind; reducing the amount of fuelwood after lighting; etc. and (b) in collaboration with the Ministry of Agriculture and the Ministry of Social Affairs, promote new food habits that are healthy, provide market outlets for domestically produced crops, and are less energy intensive than the traditional Burkinabe cuisine.

Fuelwood Substitution

21. The promotion of substitute fuels has the residual role of reducing the excess consumption that remains even where implementation of the proposed fuelwood saving and fuelwood supply management programs is deemed successful. Since electricity is not used for cooking, the increased consumption of electricity will have no impact on fuelwood demand. LPG and kerosene are, therefore, the prime substitute fuels and steps need to be taken to revitalize the LPG and kerosene promotion program. In particular, the following measures are needed: (a) improve the cooperation among the key actors; (b) increase the number of sales points for LPG; (c) introduce more technically adequate and socially acceptable stoves on the market; and (d) improve the price competitiveness of the substitute fuels.

22. The establishment of a meaningful cooperation between SONABHY (the operator of the bottling plant), the private oil companies (the wholesalers and retailers) and IBE (the stove developer) is the immediate priority for re-invigorating the fuelwood substitution program. Renewed cooperation must be based on two basic understandings: (a) effective promotion of LPG and of kerosene is achieved through the establishment of a wholesale and distribution network, and (b) wholesalers must have responsibility for its development. The present institutional framework and the price structures have to be reevaluated from this point of view.

23. The present promotion system, whereby SONABHY administers a fund, replenished by a contribution in the LPG price structure, to finance oil company proposals for promotion campaigns is not working. The established organizational framework for LPG (inter alia, the introduction of the "unitary bottle concept") does not give the private oil companies incentives to implement promotion campaigns. Instead, SONABHY should take up direct responsibility for the organization of promotion campaigns.

24. Recently developed prototypes for low-cost LPG stoves developed by the IBE should be aggressively market tested and promoted. In addition, the ongoing development work by IBE on the development of a low-cost kerosene stove, adapted to Burkinabe cooking requirements should be given high priority to broaden the substitution possibilities.

25. The LPG stove models on the Burkinabe market show considerable differences with regard to their conversion efficiency. IBE should make attempts to improve the efficiency of the low-performance stoves through changes in design. Inefficient stove models should be phased out from the commercial market in consultation with the private oil companies. Finally, introduction of an appropriate low-cost kerosene stove on the market should be considered as a high priority for the broadening of substitution policy.

Pricing Policy

26. Since the Government avoids subsidies and tries to let the price of fuelwood reflect producer costs, consumers, by and large, are provided with the correct relative economic prices. Nonetheless, by the mid-1990s, Government will need to increase the real price of taxation on fuelwood to prepare for the large scale switch to petroleum products that will be required. Because LPG and kerosene are potential mass consumption products and could become a serious drain on Government revenues, subsidies on LPG and kerosene must be avoided.

27. The Government has been less successful in providing the suppliers with the correct signals. For some actors in the price structures, e.g. the wholesalers, the margins allocated to them do not correspond to the functions they should perform in promoting the attainment of the Government's policy goals, specifically, the creation of an effective distribution system. On the other hand the margins for the retailers are overly generous resulting in the retailing activity being retained by the wholesalers. The anomalies that are identified in the relevant chapters of this Report should be corrected.

28. Concerning petroleum products, the "price stabilization fund" should protect the consumer against short-term price volatilities, but adjust to long-term changes in prices. At the present low level of international oil prices, the contributions to the fund have the character of taxation. However, if international oil prices rise again, there is a risk that the fund once more will become a drain on Government revenues as political pressures prevent a realignment of national prices to new realities. Since the state oil company SONABHY now has the monopoly for oil imports, the fund can be replaced by an annual realignment of the import-price element in the price structure in accordance with expectations concerning international price movements in the coming year. If prices turn out lower, SONABHY will make an extra profit, if they turn out higher, SONABHY will incur a loss. Since in the end, profits and losses are borne by the Government budget, the result is similar to the operation of the stabilization fund. The consumer is protected

against random short-term fluctuations in the price, but adjustment to long term changes is smoother.

Fuelwood Supply Management

29. Successful demand-side interventions could reduce the projected fuelwood consumption (about 900,000 tons) by 145,000 tons in the year 2000. Given projected demand trends, natural forest management will need to cover the major share of the increase in fuelwood demand, supplying over 313,000 tons to accomodate a tripling of urban demand between now and the year 2000. Whereas demand-side interventions dominated the previous Plan period and will continue to be important, future policy must, give greater emphasis to forestry management. Because commercial fuelwood reforestation schemes are not economically viable, there are two main avenues to increase supply: (a) closely coordinating energy policy and agricultural development policy to ensure that a maximum of the wood resources cleared for agricultural expansion are recovered for energy purposes and are not burned standing; and (b) increasing the productivity of the natural forests through the introduction of natural forest management.

30. Natural forest management is the most cost-effective way of increasing the sustainable production of fuelwood. The economics are less favourable than for the fuelwood savings program, but the magnitude of the intervention is substantial: Around 70% of the potential increase in urban household energy demand up to the year 2000 has to be covered by increases in the supply of woodfuels. To realize this increase in supply without negative environmental consequences, the rural population must be given a vested economic interest in the protection of the forest resources. The central issue in the management of the natural forestry resources is well-known - because of undefined land tenure rights: (a) no vested interest exist to protect the resource base against overexploitation and (b) under free market operations, the producer price of fuelwood will not reflect the full cost of replacement. This situation leads to overconsumption and underproduction of fuelwood simultaneously.

31. Government has taken a number of steps to provide the needed conditions to promote natural forest management. The Village Land Management Program is examining the incentive environment needed to mobilize the will and commitment of the rural population to protect its natural resources. Within this framework, the woodcutters' cooperatives must evolve towards woodland management entities and tenure arrangements clearly defined so that members not only cut the wood but manage the resource for the longer term. The present myriad of legal decrees, several of which are contradictory, seriously hinder prospects for putting sustainable forestry management plans in place. It is understood that Burkina's Environmental Action Plan is examining this issue with a view to revising the appropriate legal texts. The Government, with donor assistance, has begun to test alternative forestry management techniques and, under the ESMAP activity, has undertaken preliminary mapping of existing and potential areas of fuelwood supply within the supply zones of Ouagadougou, Bobo-Dioulasso, Ouahigouya, and Koudougou. Other measures, described in this Report, include:

(a) Completing the detailed mapping of natural woodland areas within the urban supply zones, cataloguing their presention condition and evaluating their potential productivity under management conditions;

(b) Preparing detailed management plans for areas identified for natural forest management, stipulating, inter-alia, the technical parameters of the forestry plan;

(c) Organizing the woodcutters' cooperatives into woodland management entities, and defining arrangements concerning land tenure, cost recovery, multi-purpose use of the designated management zones and other rights and obligations of the cooperatives and the Government needed to reach management targets;

(d) Introducing a system of differentiated cutting permit fees for managed and unmanaged zones and for wood coming from agricultural land clearing operations; fuelwood coming from unmanaged zones will carry a higher fee as will fuelwood coming from areas closer to the city;

(e) Creating an Urban Fuelwood Working Group, which would, inter-alia, liaise with the Ministry of Agriculture concerning fuelwood recovery on land clearing operations;

(f) Undertaking pilot projects in the different urban supply zones to test management techniques and cooperative management arrangements; and

(g) Putting in place monitoring arrangements to evaluate the results of the pilot efforts.

A Proposed Urban Household Energy Investment Program

32. This Report sets out and describes a program of investment opportunities that would assist Government to meet the above-described program objectives. It is recommended that the program be considered as an integral part of the National Environment Action Plan. For the year 2000, this program would aim for:

(a) 80% or 220,000 urban households to use improved biomass stoves to cover most of their cooking needs;

(b) 100% of the informal sector beer brewers to use the **Burkido stove**;

(c) 41% or 115,000 urban households to use LPG and kerosene stoves to cover their auxillary cooking needs; and

(d) at least 50% of commercial fuelwood to be produced by woodland management cooperatives.

33. Reaching the strategic objectives, will require Government to undertake (a) short-term actions at zero or little cost that will begin the process of policy realignment and (b) investment activities to implement the re-oriented urban household energy strategy with the help of external finance. These investment opportunities, which would reinforce on-going household energy programs, are set out in the table below:

Project Title	Total Estimated Cost in US$	Implementation Period	Funding Source
Fuel Conservation Program			
Urban Fuelwood Savings Project	1,500,000	2 years	To be identified
Institutions and Training Needs Assessment	100,000	12 months	To be identified
Inter-Fuel Substitution Program			
LPG Infrastructure Strengthening Project	700,000	12 months	To be identified
LPG Stove Development and Marketing Project	100,000	10 months	To be identified
Kerosene Promotion Options	40,000	6 weeks	To be identified
Natural Woodlands Management			
Improving inter-Agency Coordination Workshop	45,000	6 weeks	To be identified
Village-based Management of Old Fallows and Degraded Woodlands Project	5,000,000	5 years	To be identified

34. The strategy and investment program set out in this report are consistent with the energy and environmental recommendations of the Long Term Perspectives Study for Africa (LTPS). The LTPS highlights the need to address the household energy demand of the majority of the population of Sub-Saharan Africa that currently uses fuelwood and can be expected to do so over the longer term. It emphasizes the need both to broaden the use of improved fuelwood stoves as well as to encourage the shift to substitute fuels. The LTPS underscores the importance of identifying and testing different forestry management alternatives to protect the ecological base and to create an enabling environment that will encourage broad-based popular participation needed to reach this objective.

I. INTRODUCTION

1.1 In April 1985, Burkina Faso launched a far-reaching forest protection program, "Les Trois Luttes", to reduce the impact of bush fires, uncontrolled grazing and overcutting of fuelwood on its natural environment. At the same time, the Government undertook a fuelwood conservation campaign anchored in a large-scale dissemination of improved stoves and the promotion of LPG as a fuel substitute.

1.2 The UNDP-World Bank Energy Assessment for Burkina Faso ("Burkina: Issues and Options in the Energy Sector/January 1986) affirmed Government's policy direction and highlighted the household sector as its largest energy user. While not the only nor the primary cause of deforestation, the demand for fuelwood was recognized as a source of mounting pressure on an already fragile ecological base. The Assessment cautioned that urbanization, in an overwhelmingly agricultural economy, was a factor in the depletion of standing wood stocks. The report stressed the need to develop an urban household energy management strategy to reinforce Government's on-going efforts in the rural areas.

1.3 At the request of the Government of Burkina Faso, and with financial assistance from the Government of Norway and later from the Government of the Netherlands, the UNDP-World Bank Energy Sector Management Assistance Program (ESMAP) undertook preparation of an urban household energy strategy and action program beginning in 1986. The objective was to design a strategy and companion investment program to meet the urban demand for energy at the lowest cost, while protecting the country's renewable resources and limiting imports of oil products and equipment to the extent possible.

1.4 The program was executed in two phases: Phase I, from October-December 1986, carried out an overview of the urban household energy situation; reviewed on-going household energy conservation and substitution strategies and projects, and prepared a detailed project document to define priority actions to be implemented under Phase II. Phase II fieldwork began in August, 1987 and was completed in December, 1989. The findings of Phase II constitute the subject of this Report.1/ Throughout the course of this study, ESMAP and its consultants worked closely with the Ministry of Environment and Tourism (MET) and other Burkinabè institutions.

1.5 The principal outputs of this activity include:

(a) Creation of a Data Base

an energy survey of over 1100 households in five major cities.

(b) Demand Studies

(i) pilot promotion campaigns of improved wood stoves in Ouahigouya and Koudougou;

1/ *The report was written by Carolyn Tager (Task Manager), with Wolfgang Mostert (Senior Energy Economist) and Joséphine Arpaillange (Consultant). Mr. Samir Amous (ESMAP Consultant) managed the field work in Burkina Faso. Secretarial assistance and report production services were provided by Sophie Warlop.*

(ii) testing of door-to-door sales of improved wood stoves; stove acceptability test in Ouagadougou.

(c) Supply Studies

(i) testing of stove efficiency (improved wood, kerosene and LPG stoves);

(ii) a study of the production and marketing structure for improved stoves;

(iii) a household petroleum product distribution study;

(iv) a forestry management study and preparation of forestry management strategies for Burkina's 4 major urban centers.

II. BACKGROUND

A. Economic and Demographic Trends

2.1 With a GDP per capita of US$ 297 in 1987, Burkina Faso is one of the world's poorest countries, its development constrained by an array of natural obstacles. Agriculture is its most important economic activity, employing almost 90% of the population, accounting for one-third of GDP and virtually all of its exports. Yet, the natural resources on which agricultural output depends are meager and increasingly vulnerable to the effects of rapid population growth. Soils are generally shallow, poorly structured, and easily degraded by traditional methods of cultivation. Rainfall is scarce and highly variable, both among regions and from year to year. The country has located important mineral deposits, but its landlocked position and poorly maintained transportation network make the cost of their exploitation relatively high.

2.2 An annual population growth of approximately 3.3 percent is regarded by many development planners as the country's most serious challenge to promoting the sustainable use of its natural resources. The uneven distribution of this population is also a constraint and is felt in declining fallow periods, accelerating deforestation, and deteriorating soil fertility, especially on the central plateau. A small but rapidly increasing share of the total population lives in urban areas, accounting for approximately 11% of the total population of 9.8 million in 1989. The present urban growth rate of about 8% a year is more than double the overall population growth rate and shows no signs of slowing down. By the end of the century, total population is projected to be at least 12.5 million, with the urban share reaching 21% of the total, or 2.4 million. Ouagadougou, the capital and largest city, accounted for about 50% of the urban population in 1985 and its annual growth rate averaged 9.5% between 1975-1985. Bobo-Dioulasso, next with approximately 213,000 inhabitants, accounted for 25% of the urban population, growing annually at 7%. These two cities are expected to at least triple in size within 15 years, fueled by the high natural population growth and by uncontrolled internal migration.

2.3 The share of economic activity located in urban areas is striking, given the still low level of urbanization. Over the period 1982-1987, an average 68% of GDP (constant 1979 prices) was accounted for by urban-based activities (28% by industrial and 40% by service-related activities), almost exactly the reverse of the situation in 1960. Despite notable strides in boosting agricultural output during 1982-1987 alongside slower growth in the manufacturing and tertiary sectors, the importance of the urban sector to overall economic growth will not diminish. Indeed, as national development policy shifts towards creating conditions more favorable to private sector growth, improving public resource management and removing physical and institutional constraints, the economic role of the urban sector will be further enhanced. The downside of this scenario is an annual increase in urban residents of between 80,000 and 90,000 each year and the pressures of these numbers on already deteriorated living and working conditions. The impact of this explosive growth is visible in the hinterlands of the major urban centers, especially Ouagadougou, where soil degradation and erosion are the most severe, the combined effect of land clearing for agriculture and the accelerating demand for fuelwood for energy.

B. Energy and the Environment

2.4 The Government is deeply concerned about the accelerating depletion of its natural resources and the need to move both boldly and quickly. It is, therefore, not surprising that the implementation of a program to reverse the ecological decline has ranked high on the country's development agenda since the early 1980's. This commitment was an explicit objective of the 1986-1990 Five Year Plan, togther with (1) controlling population growth and migration, (2) achieving food security, (3) improving the management of the economy and (4) improving the role of women in development. A broad range of international and bilateral donors and NGOs endorsed these priorities through a series of programs that began as early as 1985. More recently, the Government appealed directly to IDA for assistance to elaborate a more comprehensive and coordinated national environmental plan and investment package.

Energy Balance

2.5 Energy policy is a critical instrument of environmental management for Burkina Faso as fuelwood is the principal source of energy. The household sector is the most important fuelwood consumer, accounting for 3 million tons per annum and for 98% of household primary energy demand. Energy consumption by sector and fuel type is depicted in Table 2.1. Reflecting Burkina's low level of industrialization, the household sector (including informal sector productive activities) accounted for 88% of national final energy consumption in 1987. Transport followed with 6%, industry/agriculture 4% and the public sector 1%.

Table 2.1: Final Energy Consumption by Sector, 1987
(000 of toe)

Sector	Biomass	Oil Products	Electricity	TOTAL
Households	1256	13	12	1281
Transport	-	85	-	85
Industry	39	12	21	72
Public Sector	-	9	2	11
TOTAL	1295	119	35	1449

Source: ESMAP estimates. Electricity consumption reflects SONABEL sales only, as extent of autoproduction of electricity is unknown, although probably very minor.

2.6 **Consumption of biomass fuels** accounts for 89%, oil products for 8%, and electricity for 2% of final energy consumption. Biomass is consumed primarily in the form of fuelwood (91%); next is agricultural residues (5%); bagasse (3%) and charcoal (1%). It is important to note that, although the household sector is the dominant consumer of biomass fuels, biomass is the most prevalent energy source even in industry, where its consumption is three times as high as the consumption of oil products.

2.7 Burkina's overall energy consumption in 1987 of 1.45 million tons oil equivalent (toe) is one of the world's lowest, expressed in terms of per capita energy consumption (160 kg of oil

equivalent); in terms of per capita consumption of oil products (17 kg); or in terms of per capita consumption of electricity (14 kWh). Yet even the satisfaction of this low level of demand for oil products represents a very real challenge to policymakers. In 1987, the cost of importing 130,000 tons of oil products 2/ amounted to US$ 47 million, equivalent to 16% of export income and to 6.5% of total imports of goods and services. Given these high costs and competing development priorities, the transition from biomass to modern fuels must be carefully planned. Indeed, given Burkina's well documented development constraints and prospects for future economic growth, the key energy issue facing the country is how to achieve an ecologically sustainable balance between fuelwood demand and fuelwood supply with minimal consequences on oil imports.

Household Energy Demand

2.8 While urban household energy demand is growing more rapidly, household energy consumption in Burkina Faso is dominated by the rural sector. Rural household energy consumption is about 8 times higher than that of the urban sector as shown in Table 2.2 below.

Table 2.2: Rural and Urban Household/Informal Sector Energy Consumption, 1987 a/
(tons, electricity = GWH)

	Fuelwood	Charcoal	Agr.Res.	LPG	Kerosene	Electr.
Rural Household	2,700,000	-	200,000	-	7,600	n.a.
Urban Household	252,000	12,000	-	660	3,600	35
Urban Inf.Se.	41,000	2,000	-	n.a.	n.a.	n.a.
Total	2,993,000	14,000	200,000	660	11,200	35

a/ Consumption of electricity= extrapolation of 1986 Sonabel figures
Other consumption per capita per year: Rural consumption of fuelwood = 365 kg; Urban household consumption = results from ESMAP/MET's surveys of consumption in the four major cities, other cities = 235 kg of fuelwood + 11 kg of charcoal; urban informal sector = extrapolation to all cities of ESMAP Ouagadougou surveys.

If it is assumed that the factors influencing household energy consumption are held constant over the next decade, that annual population growth is 3.3% and urban population growth is 8%, rural biomass consumption will amount to 3.8 million tons fuelwood equivalent 3/ and urban consumption of fuelwood to 0.9 million tons in the year 2000. 4/ After the year 2000, however, the picture

2/ *1987 consumption was higher: 153,000 tons.*

3/ *With an estimated energy content of 2,500 Kcal/kg, the consumption of 200,000 tons of agricultural residues in 1987 and 250,000 tons in the year 2000 corresponds to a "saving" of 130,00 tons and 160,000 tons of fuelwood respectively.*

4/ *Charcoal is derived from two sources (a) as a residue from the burning of fuelwood (mostly supplied from the informal sector beer brewers) and (b) from the commercial carbonization of fuelwood. If it is assumed that 15% of the energy content of used fuelwood in informal sector beer production is retained in marketed "residue" charcoal, the 1987 supply from this source amounted to 2,500 tons. In the year 2000, the supply would amount to 6,000 tons (increase equivalent to urban population growth). Based on these assumptions, commercial production of charcoal can thus be estimated at around 8,000 tons in 1987 and would rise to about 26,000 tons in the year 2000. At a carbonization rate of 20%, this translates into a use of 40,000 tons of fuelwood in primary production in 1987 and 130,000 tons in the year 2000.*

changes under the impact of continued high urban population growth: about 80% of the potential increase in fuelwood demand between 2000 and 2010 will come from the urban sector (see Annex I).

2.9 As depicted in Table 2.3 below, the structure of fuelwood consumption for cooking in Burkina's major urban centers reflects the population's rural roots, its low level of income, and the high cost of modern fuels. Only a minority of urban households uses modern fuels to cover some or all of their energy needs.

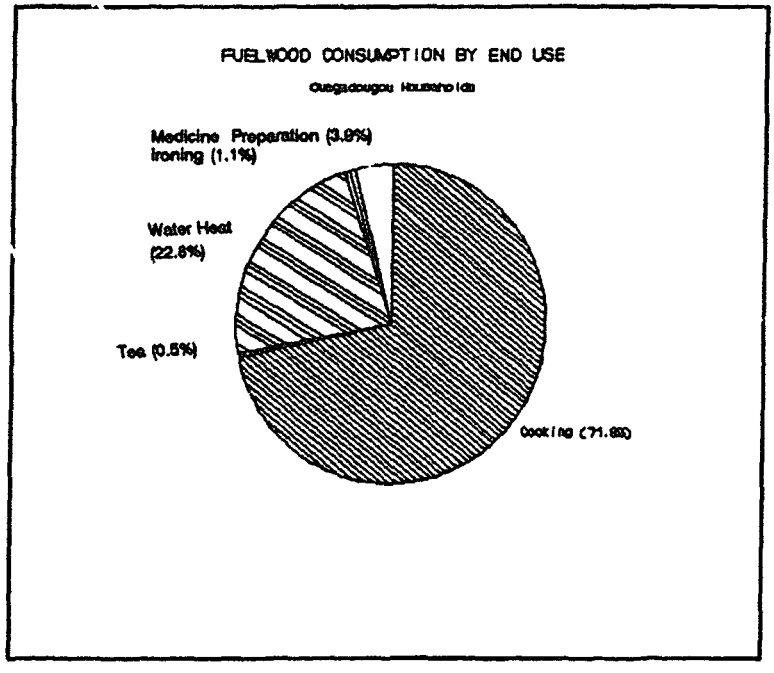
Table 2.3: Fuel Use for Cooking (in Urban Population)

Fuelwood	91%
Charcoal	64%
LPG	7%
Kerosene a/	3%
Vegetal residues	1%

a/ Use for lighting not included
Source: ESMAP

2.10 The 1987 ESMAP/MET household energy survey showed that households cook an average of 1.5 hot meals per day and that this use accounts for about 3/4's of urban household energy demand in Ouagadougou as well as in Ouahigouya (the most rural of the four largest cities). The structure of household energy use in Ouagadougou is shown in Figure 2.1:

Figure 2.1: Ouagadougou Household Fuelwood Consumption by End-Use, 1987



Source: ESMAP/MET Household Energy Survey 1987

2.11 Urban households consume on average 644 grams of fuelwood and 30 grams of charcoal per capita/day, or a total of 693 grams per capita/day of fuelwood equivalents (calorific basis). **Seasonal differences** in consumption between the cold (December to February) and the warm period (the remainder of the year) are relatively modest, varying between 3% in Ouahigouya and 13% in Bobo-Dioulasso. **Regional differences** in fuelwood and charcoal consumption are higher: Consumption is lowest in Ouagadougou with 658 grams/per capita/day and highest (+23%) in Ouahigouya with 838 grams of fuelwood equivalents per person and per day. Preparation of medicine uses less energy in Ouagadougou than in Ouahigouya, because of a higher consumption of modern forms of medicine. The relatively high availability of fuelwood and the possibility for self-collection are other factors that induce a high consumption of fuelwood in Ouahigouya.

2.12 Factors influencing energy consumption. The three important socio-economic factors that influence energy consumption are household size, income elasticity and price elasticity. The implications of these factors are analyzed in Annex II. Because of economies of scale in energy consumption, smaller households have higher per capita consumption of household energy than larger households. Thus, a family of four will typically consume twice as much as a family of 13. Household energy consumption increases with income, but the effect in the case of fuels other than electricity is modest, owing to the basic needs character of household energy demand. Similarly, the price elasticity of household energy demand is low: a doubling of price will only decrease demand by about 15%.

2.13 LPG and kerosene consumption. **LPG consumption** is entirely an urban phenomenon, limited to 9% of urban households who use it principally as a secondary fuel. Consumption expanded during the mid-1980's, but has since stagnated because most of the households in the "captive market"--the upper income groups-have already switched to LPG. **Kerosene** is widely used in both urban and rural households, but its use is limited almost exclusively to lighting.

2.14 LPG-consuming households differ from the average fuelwood-consuming households in three aspects: these households are richer; they are smaller (see Table 2.4) and have a preference for meals that are less energy intensive than the traditional Burkinabe meal: Whereas "tô", (Burkina's food staple made of millet and sauce) makes up 60% of the daily diet in fuelwood-consuming households, it represents only 12% in LPG-consuming households. Per capita consumption of household energy in LPG-consuming households is, as a consequence, lower than in other households, although the opposite would have been predicted on the basis of their size and income. 5/

5/ *In part, the lower level of consumption may be due to a higher propensity to eat outside the house.*

Table 2.4: Household Size and Average Consumption in LPG Consuming Households

	Average Size	Cons.of LPG per capita/ day	Total cons.incl. fuelwood in fuelwood equivalent a/
Non-gas using households	8.9	0	709 grams
Use of gas as aux. fuel	7.9	19 grams	721 grams
Use of gas as main fuel	4.1	60 grams	575 grams
Use of gas as only fuel	3.1	60 grams	413 grams

a/ Calculated on the "useful energy equivalency" 1 kg of gas = 7 kg of fuelwood

Source: ESMAP/MET Household Energy Survey, 1987

2.15 Electricity. Electricity consumption is almost exclusively an urban phenomenon. As depicted in Table 2.5, only 22% of households in the five largest cities are connected to SONABEL's grid and consume, on average, 1043 kWh per year. If some of the connected households sell electricity to their neighbors, the percentage is probably higher (raising it by a third, based on the experience in other low-income countries) and thus, per capita consumption is slightly lower. Surprisingly, the connection rate is lowest in Ouagadougou (20%) and highest in Ouahigouya (33%); average annual consumption per connected household, on the other hand, is highest in Ouagadougou (1429 kWh) and lowest in Ouahigouya (309 kWh).

Table 2.5: Penetration of Electricity in Urban Households, 1987 (kWh)

	Connected Households	In percent of household	Average annual Consumption
Ouagadougou	17,710	20	1429
Bobo-Dioulasso	9,552	25	733
Koudougou	1,928	22	467
Ouahigouya	1,941	33	309
Banfora	1,943	28	260
Total	33,074	22	1010

Source: SONABEL

2.16 Given current trends, the percentage of connected households in the five largest cities will increase to 44% by the year 2000 and urban household demand will increase from 34 to 170 GWh. Because electricity serves other purposes than cooking, it will not influence fuel consumption apart from the use of kerosene for lighting: Compared on a useful energy basis, present electricity tariffs are three times as high as fuelwood. 6/

6/ *Cost per kWh (3.6 MJ) in Ouagadougou in 1987 is 87.8 CFAF. Assuming a 60% efficiency for the electric cooker, this amounts to 40 CFAF/useful MJ. 1 kg of fuelwood (16 MJ) costs 25 CFAF, or, at a 14% traditional cooker efficiency, 11 CFAF/useful MJ.*

2.17 Fuelwood demand in the informal sector. The informal sector is an important source of urban and, in particular, female employment and comprises both secondary and tertiary activities. The most important energy-consuming activities take place in the informal production of millet beer (**dolo**); in commercial food preparation: street stalls and street barbecues; and in bronze foundries producing tourist items and cookware. These activities account for about 16% of urban household energy demand as shown in Table 2.6.

2.18 Energy intensity of **dolo** production is high: The ESMAP/MET surveys showed a consumption of 1 kg of fuelwood per liter of **dolo** produced, making the **dolotières** a clear target for energy savings campaigns. The fuelwood demand of other small-scale productive activities, e.g. bakeries, roadside restaurants, etc. is unknown, but warrants further investigation. Taking all such activities into account, it is likely that fuelwood demand across the informal sector accounts for about 20% of the total commercial demand for fuelwood and charcoal. Here again, however, national figures can mask important regional variations in consumption: in Koudougou, millet beer accounts for 38% of total urban fuelwood consumption.

Table 2.6: Informal Sector Fuelwood Consumption in Ouagadougou (tons)

	Number	Fuelwood	Charcoal	Total fuelwood a/	in %
Dolo produ.	589	16,000	-	16,000	11
Food stalls	409	3,900	30	4,000	3
Barbecues	394	800	660	2,500	2
Pot foundries	30	-	230	600	0
Bronze foundr.	16	60	30	1,0	0
TOTAL	-	20,760	950	23,210	16 b/

a/ Conversion of charcoal to primary fuelwood consumption based on 20% carbonization rate; half of the charcoal is assumed to be recovered from fuelwood consumption, half from tree-felling.

b/ Household consumption = 85%

Source: 1988 ESMAP/MET surveys.

Biomass Resources

2.19 Burkina's woodfuel demand is met by its natural forests. They are mainly in the form of savannah bushlands and cover nearly 50% of the territory. This report estimates that deforestation is occuring at an annual rate of 60,000 hectares of which 40,000 for land clearing for agricultural expansion; the remainder is the result of bushfires, drought and the cutting of wood for fuelwood consumption in mostly unmanaged forests. Total natural wood production is currently estimated to be about 10 million m3 (6-7 million tons) per year. Of this amount, the MET, estimates that 2.5 million tons are available for fuelwood consumption in the sense of being accessible to the local population and corresponding to local demand. The construction of new access roads will, over time, increase the amount of accessible fuelwood, and higher fuelwood prices will bring remote areas into the commercial fuelwood circle. The deficit in 1987 of 0.5 million tons, representing the difference between demand and currently sustainable supply is met by clearing of

the forest cover (cutting of green or of remaining dead wood). How much of this is a by-product of the clearing of agricultural land and how much is due to the rapid growth in the urban demand for biomass is unknown.

2.20 The imbalance between fuelwood demand and sustainable supply is bound to increase in the future, fueled by the high rate of population growth in general and by rapid urbanization in particular. The growth of population from 9.8 million in 1989 to 12.5 million in the year 2000 will boost annual fuelwood consumption from 3 million tons to 4.5 million tons and urban consumption from 0.33 million to 0.9 million tons by the year 2000. The counterbalancing forces to this potential tripling of the urban demand for fuelwood are too weak to reverse this projected increase. An estimated rise in per capita income of 1-2 per cent a year is too low, by itself, to accelerate fuelwood substitution. Moreover, the standing volume of wood is still sufficiently large to meet the rising demand for fuelwood with little or no upward pressure on prices until after the year 2000.

Managing the Fuel Transition

2.21 Given Burkina's development constraints, Government has limited policy options to manage the fuel transition: it must maximize fuelwood consumption within the urban household sector over the longer term, while seeking socially acceptable and affordable means to introduce the use of petroleum products for household energy tasks across a wider spectrum of the urban population than is currently the case. Government's emphasis since the early 1980's has been largely on the rural sector where the majority of the Burkinabe population resides. It is, however, notoriously more difficult to introduce demand management through improved stoves in the rural sector, both because the population is widely dispersed and because rural households have less financial motivation to reduce consumption of self-collected fuel. Furthermore, the preservation of the forest cover is a remote concern of poor rural households for whom daily survival strategies are first priority. The lackluster penetration of these improved stoves into rural households is ample evidence; a 70% penetration fell to half that figure after the first year of the program. 7/

2.22 Since Burkina Faso's population is and will remain predominantly rural well into the next century, energy savings measures should continue to be promoted in the rural sector, provided these actions are re-formulated and resources more efficiently deployed. Because the rural population tends to meet its fuelwood requirements from dead wood, the impact on the environment is marginal--if at all. Where green wood is consumed, it is more typically the result of clearfelling for agricultural development. This destruction of the forest cover is not energy-related and, therefore, cannot be expected to respond to energy-related programs.

2.23 The rapidly growing urban sector poses a far more serious problem for the management of these natural resources, and must become the prime focus of future efforts. Between now and the year 2000, it is the intensive and concentrated urban fuelwood demand that will contribute directly to environmental degradation, since a rising share of this natural resource is mined exclusively for the urban market. Because these mined areas are not used for agricultural purposes

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7/ *A 1988 tri-partite review of donor involvement in Burkina's Bois de village program, one of several popular-based initiatives to reverse the depletion of its resources, underscored the apparent indifference of the rural population to the benefits of improved stove use. This evaluation also noted that, even in the most deforested zones, the rural population appeared adequately stocked with fuelwood and rarely cited its absence of fuelwood as problem.*

and are unprotected from wind and rain, soil degradation is most severe. Actions to restrain urban demand must, therefore, be directed, in the short term, to reversing the widespread environmental decline on the central plateau. If today, Ouagadougou accounts for half the country's urban population, this share will climb to two-thirds by the year 2000. The level of urban demand will be 2.6 times higher than in 1987, putting heavy pressure on the commercial fuelwood supply system. The most immediate impact of increased wood scarcity will be on household welfare and, especially, among the growing ranks of the urban poor. They could be expected to face higher woodfuel prices towards the year 2010 or shortly thereafter, a lower per capita consumption of cooked food and a shift backward on the fuel ladder to less desirable fuels.

C. Government Household Energy Strategy

Household Energy: A National Program

2.24 The Government's 1986-1990 Five-Year Development Plan called for an ambitious household energy program. The program consisted of actions in:

(a) demand management- consisting of (i) disseminating improved woodstoves, with a particular focus on the rural population; and (ii) promoting LPG and kerosene as substitute fuels in the urban sector; and

(b) supply management- changing the price structure of fuelwood in favor of fuelwood producers and encouraging the creation of woodcutters cooperatives.

By 1990, the strategy aimed to: have two-thirds of all households using an improved fuelwood stove; 32,000 urban households using an LPG stove; reach an annual consumption of 4,800 tons of LPG; market improved stoves for modern fuels and, in particular, LPG and kerosene; and protect and generate wood resources.

2.25 Program performance. Government made significant strides in implementing its program, although by the end of the Plan period, original targets will not have been met. The ESMAP household surveys highlighted this fact and the MET, responsible for program execution, undertook some, albeit limited fine-tuning of the program in 1988. This data showed that, at the end of 1987, about one-third of urban households were using an improved woodstove, although it was but one of several cooking devices in use. While 100,000 stoves had been constructed by the rural population, early enthusiasm for the program by the population waned quickly for several reasons. Access to self-collected fuelwood is one. Another reason appears to be due to the fact that many rural women attach greater importance to reduced cooking time than to reduced collection time and many women found that cooking times increased with the new stoves. In addition, poor rural households appear to attach limited priority to environmental protection and its link to improved stove use. On the fuel substitution side, 9% of households in the four major cities had acquired an LPG stove and overall demand for LPG had increased from 745 tons in 1985 to 1476 tons in 1987. Finally, following a reorganization of the fuelwood supply structure in 1985, fuelwood prices had climbed by 60% in Ouagadougou with household demand dropping to a level that was, on average, 9% lower than average fuelwood demand in the three other major cities.

2.26 By 1988, the program had stalled. LPG sales had leveled at 1,500 tons per annum and the pace of sales of improved woodstoves (6,000-7,000 per annum) was below that needed for stove replacement and to keep up with the growth of the urban population. The improved stove program was resulting in savings of approximately 15,000 tons of wood per annum or 7% savings of total household fuelwood consumption per annum. However, the annual formation of about 12,000 new urban households, representing 23,000 additional tons of firewood per annum, wiped out these gains. Furthermore, of households with monthly incomes below 20,000 CFAF, only 18% had acquired an **improved 3-stone stove** and only 5% an **improved metal stove** promoted by Government's program. Data from the ESMAP surveys further indicated that efforts to instruct the urban population on more efficient cooking methods (e.g. protection from wind; use of a lid; fewer pieces of wood; recovering and recycling the charcoal etc.), not now a major focus of Government's promotion campaign, could generate fuelwood savings that could equal those resulting from the efficient utilization of the improved stove.

2.27 Efforts on the supply side in favor of reforestation had produced modest results. Industrial plantations had not proven cost-effective for fuelwood production. Village afforestation schemes faced growing organization and implementation difficulties. Thorny issues including those of land tenure, traditional patterns of cultivation, village politics, internal migration trends, to mention but a few, further complicated an extremely complex issue. The following chapters examine program performance in more detail.

Institutions and Policy Framework

2.28 There is institutional fragmentation in the energy sector, making policy and program definition and coordination difficult. In the absence of a Ministry of Energy, ad hoc administration and definition of energy issues is the province of the sectoral ministries and state companies. Regular overall energy planning is not done except in conjunction with the preparation of the five year plans; program evaluation is an infrequent instrument of sector development. Project implementation has top priority because the bulk of the sector's investment comes from external sources. This approach has had the advantage of providing a rich environment for testing and experimentation in household energy, where, indeed, there have been few precedents. At the same time, this dispersion of scarce resources in the Burkinabe context is not easily defended. Finally, the absence of indicators to measure performance means that corrective action is often taken late and in an improvised manner.

2.29 The Ministry of Environment and Tourism (MET) is the key actor in household energy and will continue to be so as long as this sub-sector's consumption is primarily based on biomass. The MET is responsible for the management of fuelwood supply (forest management and fuelwood distribution issues) and for the demand management of fuelwood (fuelwood pricing and improved wood stove programs). It collaborates with the Ministry of Agriculture (MAE) in the implementation of village forestry schemes and natural forest management projects and in the diffusion of the **improved three stone stove** in rural areas. It implements the urban improved stove program through its Extension Service (DSVF). The Family Ministry, (MEFSN) plays an advisory and a policy dissemination/educational role in promoting improved wood stoves and the use of substitute fuels such as LPG.

2.30 The Ministry of Commerce (CAPRO) is responsible for the pricing of petroleum products and, together with the MET, for setting retail prices of charcoal and fuelwood. CAPRO fixes the price structures on the basis of recommendations from the responsible inter-ministerial committee.

2.31 Founded in 1982, the Burkinabe Institute for Energy (IBE), under the Ministry of Higher Education and Scientific Research (MESRS), is responsible for energy research of a technical and policy nature. The IBE developed the improved woodstove and charcoal models that are disseminated in Burkina Faso as well as prototypes for a domestically produced LPG stove and a kerosene stove. In collaboration with the Ministry of Labour, it has trained local blacksmiths in the techniques of the production of improved woodstoves. Finally, the IBE has assisted the MET in the implementation of dissemination campaigns for improved woodstoves and in the evaluation of results.

2.32 SONABHY, the national oil company founded in 1985, has the monopoly for the imports of oil products and is responsible for the formulation of sector policies.

2.33 The two most important inter-ministerial committees in the field of energy are the Inter-ministerial Committee for the Promotion of Improved Woodstoves and the Commission for the Promotion of LPG, created in 1984. The former is chaired by the MET and composed of representatives from the National Secretariat General of the Comites revolutionnaires (CRs), of the MEFSN, the MESRS, the MAE, the Ministry of Labour, the Ministry of Social Security and the Ministry of Information and Culture. The latter Commission is presided by SONABHY and is composed of members from various ministries, such as the MET, CAPRO and IBE. The impact of this structure on program formulation and implementation is one of predictable overlap and inefficiency.

2.34 Notwithstanding the inter-ministerial committees, the different actors work in relative isolation in the same or complementary fields. These committees have met infrequently in the past and suffer from a lack of staff continuity. Their unclear roles vis-a-vis the responsibilities of the line ministries is also a constraint. The institutional framework for environmental management is receiving close scrutiny within the preparation of the National Environmental Plan and should include the ministries and other agencies responsible for household energy and fuel substitution as described in this report. The various components of the Government's household energy strategy that are the responsibility of ministries and agencies depicted above are described and analyzed in the following chapters.

III. DEMAND MANAGEMENT: DISSEMINATION OF IMPROVED STOVES

A. Program Context

3.1 Spurred by bilateral support, the improved woodstove program became the linchpin of Government efforts in the fight against desertification. Bilateral aid forestry projects and non governmental organizations (NGOs) first introduced the so-called improved woodstove in Burkina Faso as early as 1979. These attempts, however, were fragmented and improvised and produced stoves that were ill-suited to local conditions. With the creation of the IBE in 1982, Government sought to shore up its efforts by heightening control over all facets of the program. IBE was designated as the national center for the development of improved stoves and the Extension Service of the MET, the DSVF, subsequently became the coordinating entity and executing arm of the Inter-ministerial Technical Committee for the Promotion of Improved Stoves.

3.2 Commercially produced improved woodstoves are more costly than traditional wood stoves: they are more complicated to produce and use more material. Similarly, self-constructed improved woodstoves are more labor-intensive than traditional self-constructed stoves such as the 3-stone stove, and may, in addition, require some financial outlays for the material. The crucial issue for the future of the stove dissemination program thus becomes how to market and gain widespread consumer acceptance of a new product that has a higher purchase price than alternative, established products (demands more labor in construction). It promises lower operating costs (saves labor for fuelwood collection) during its lifetime, but offers no significant user advantages nor satisfies additional wants. 8/

3.3 The improved wood stove has, therefore, characteristics more similar to a savings asset than to a new consumer product. This feature poses some marketing disadvantages, particularly in a low-income country such as Burkina Faso, where many consumers face chronic cash flow problems. A savings decision is more likely to be postponed than the satisfaction of a consumer want. Lowering the higher price of the improved stove will be, as a consequence, key to a massive dissemination of improved woodstoves.

3.4 A successful stove program must have the following elements:

(a) stove models that (i) are more energy efficient than traditional stoves; (ii) meet widespread consumer acceptance and (iii) have a favorable investment/savings ratio;

(b) a production system that (i) is cost-efficient; (ii) has sufficient supply flexibility to satisfy increases in demand; and (iii) delivers a reliable product;

8/ *The additional advantages they may have are offset by their inconveniences. Faster cooking time is often claimed for improved stoves. However, according to the MET and the IBE, what is gained in cooking is lost in time spent for extra splitting of fuelwood and in extra cleaning of the pots (the more concentrated nature of the smoke makes the pots dirtier). They also claim that, in the rainy season when the wood is wet, improved stoves are more difficult to light.*

(c) a distribution system that is efficient, autonomous and able to reach the mass consumer; and

(d) a marketing approach that (i) reaches the majority of consumers and (ii) convinces the consumer of the advantages of the product.

3.5 The following paragraphs will examine the performance of Government's stove dissemination efforts in light of these features.

B. The National Improved Stove Program

Stove Models

3.6 Household stoves. IBE's research and development in improved stoves has been a key factor in the achievements of Burkina's improved stove program. IBE has developed three stove models: the **improved 3-stone stove**, mainly for use in the rural areas, is self-constructed, made of clay and non-portable; and two portable metal stoves that are commercially produced for the urban market--the **Ouaga métallique** for fuelwood and the **Burkina mixte** for fuelwood and charcoal. All are single-pot models. Prototypes of ceramic stoves have been test marketed since 1984, and a prototype for a **multi-pot improved metal stove** exists.

3.7 Laboratory and user tests showed that the improved stoves are 26-30% more energy-efficient than the **traditional 3-stone** and traditional metal (**malgache**) stoves. The price/energy cost savings relationship is also favorable. The **malgache** stove costs 300 CFAF, the **Ouaga métallique** between 650-950 CFAF (depending on the size of pot for which it is constructed), and the **Burkina mixte** between 1,300-1,650 CFAF. Average annual fuel savings for a household amount to 235 kg per improved metal stove, or 5,900 CFAF in Ouagadougou and 3,500 CFAF in other cities. 9/ The higher cost of an improved metal stove can, therefore, be recovered as fuel savings within 4 months in Ouagadougou and within 6-7 months in the other cities.

3.8 Results of limited market tests carried out by ESMAP/IBE in late 1988 (door-to-door sales and a pilot consumer acceptability test) seem to confirm the existence of a consumer demand both for higher priced metal stoves and for ceramic stoves, as depicted in Table 3.1. The **Burkina mixte** is almost 50% more expensive than the **Ouaga métallique**, yet due either to the ease of firing or its appearance (or both) it achieved the highest level of sales. Perhaps the most revealing result of these limited pilot tests is that 60% of the households in the poorest income category purchased a metal stove, providing some hope that daily cash restrictions at this income level would not pose an insurmountable obstacle to a wider penetration of improved metal stoves.

9/ *Cooking tests performed by ESMAP/MET at the IBE showed that the improved 3-stone stove is 26% and the improved metal stove 30% more energy efficient than the traditional 3-stone stove. The savings compared to the malgache stove are slightly lower. Average annual fuelwood consumption in families using an improved 3-stone stove amounts to 2,300 kg. Since the improved metal stove is used for 60% of the stove tasks, annual savings should amount to 400 kg.*

Table 3.1: Market Prospects for Improved Stoves
Door-to-Door Sales and Acceptability Tests
(distribution of sales of improved stoves in %)

	Door-to-door sales	Consumer acceptability test <20,000	20,000-49,000	50,000-99,000	Total
		(household income in CFAF)			
Ceramic stove	10%	25%	27%	4%	17%
Ouaga Métallique	32%	56%	33%	26%	37%
Burkina Mixte	58%	19%	40%	70%	46%

Source: MET/ESMAP pilot projects 1988

3.9 The advantage of the single pot improved stove is its high efficiency. However, households continue to rely on traditional stoves for larger sized pots. It may well be that the lower efficiency of the **multi-pot stove** is more than compensated by a higher level of use. Both the energy efficiency and the overall level of utilization of the **multi-pot stove** need to be tested in the information campaigns designed to promote more widespread use of this equipment. If more families use **multi-pot stoves** for most of their cooking and heating requirements, important energy savings could be generated.

3.10 Informal sector stoves. Since approximately 60% of fuelwood consumption in the informal sector takes place in the production of **dolo** (millet-based) beer, IBE concentrated its efforts on reducing fuelwood consumption during this process. A prototype (the **Burkido**) stove for **dolo** production was developed by IBE. According to test results, it reduces consumption by 30%, if used correctly. Although this stove was developed in 1986, there is little information on its performance nor on the number of stoves purchased by the women **dolotières**. If the energy savings generated during laboratory testing hold in practice, the **Burkido** should be assured of a rapid dissemination. The investment cost is no higher than the cost of three weeks of fuel consumption for a **dolotière** as shown in Table 3.2. Furthermore, if correctly used, the investment cost of the **Burkido** can be recovered within three months as the value of fuelwood savings. During the average 3-year lifetime of the stove, it is estimated that some CFAF 360,000 of fuelwood savings could be generated.

Table 3.2: The "Burkido Stove"
Basic Data

Average cost of investment in Burkido	: 30,000 FCFA
Weekly fuelwood consumption of dolotière using traditional stove	: 500 kg
Average monthly fuel expenditures of a dolotière using traditional stove	: 45,000 FCFA
Expected fuel savings from use	: 30%
Monthly value of 30% fuel savings	: 13,000 FCFA

C. Stove Production and Distribution

3.11 Public sector role. Since the outset of the program, production and distribution of improved stoves in Burkina Faso have been characterized by a general across-the-board involvement of the public sector. The DSVF intervenes throughout the production-marketing chain, from the supply of scrap metal to the blacksmith on a loan basis, until the delivery of the improved stoves to the consumer, and fixes the prices and revenues at each level of the chain.

3.12 Informal sector artisans. For reasons of social equity and employment generation, the Government tapped local artisans to produce the improved stoves. Since the blacksmiths were already producing the **traditional malgache** metal stove, it was deemed cost effective to build on an existing structure of stove production and distribution, which had clearly demonstrated its ability to satisfy customer preferences at low cost. Since the program's inception in 1984, 66 blacksmiths have been trained in the four major cities. Templates are used to reduce production time and meet energy efficiency specifications, although quality control has not been consistently practiced.

3.13 Depending on the type of product (water cans, pots, pans etc.) blacksmiths use either new metal (2,460 CFAF per m^2) or scrap metal (1,050 CFAF per m^2). Since scrap metal is used to produce the **malgache** stove, it was decided to do the same for the improved stoves. This policy makes sense, since the metal component is the principal determinant of the cost of the stoves (see Table 3.3 below).

Table 3.3: Price Structure of Improved Metal Stoves (FCFA)

	Ouaga metallique	Burkina mixte
Cost of scrap metal a/	550	900
Labour costs b/	280	400
Total cost of production	830	1,300
Official producer price	650	1,300
Official retail price	750	1,400

a/ Based on the DNSV price for scrap metal in Ouagadougou in 1988.
b/ Based on normal minimum revenues for blacksmith assistants in 1988.

Source: ESMAP/MET Survey, 1987

3.14 However, this is only a medium-term solution. Burkina's main source of scrap metal for the improved stove comes from used oil drums, of which a total of 6,000 are available annually from major industries. Approximately 18,000-22,000 improved stoves can be produced from this supply. If, however, a 50% penetration rate of improved stoves in urban households were to be achieved by 1993, a supply of 70,000 stoves would be needed. 10/ Given present trends, the

10/ *20,000 to be purchased by households that do not possess an improved metal stove and 50,000 for replacement of worn out improved metal stoves (3-year lifetime).*

prospects are dim for identifying sufficient scrap metal to meet this higher level of demand over the longer term and some of the production of the improved stoves will have to be based on new metal. 11/ Since this will increase the cost of the stove by 1,000 CFAF, the market will need to be segmented and market outlets identified for these higher priced stoves. 12/

The Incentive Environment and Stove Production

3.15 In order to keep the consumer price of the stoves as low as possible, the DSVF fixes both producers' and retailers' margins. These margins have discouraged broader artisan participation in stove production. In the case of the **Ouaga métallique**, the producer price does not cover production costs, unless producers can obtain scrap metal at prices that are lower than those charged by the DSVF. 13/ The producer margin for the **Burkina mixte** is more realistic, but still lower than margins on alternative products: blacksmiths can earn 850-1,250 CFAF per day producing the improved metal stove; producing other articles, they make about 1,800 CFAF. As a result, most of the trained blacksmiths have abandoned the production of the improved metal stove. 14/ Those producers who continue to participate assign production to their apprentices, who take up production of improved stoves when there is nothing else to do. In the absence of any follow-up training by IBE, this situation accentuates the problem of quality control.

3.16 Distribution arrangements are no better. The retailers' margin (100 CFAF per stove) is so low that the traditional distribution system for the **malgache** shows no interest in promoting the improved stoves. Once produced, the stoves are then purchased by the DSVF. This arrangement reduces the incentive for producers to develop their own marketing channels and further entrenches the public sector within the program. In contrast, the production and distribution of traditional **malgache** stoves functions efficiently without any supply bottlenecks. The demand for the **malgache** stove is stable and scrap metal is secured by the blacksmiths through traditional channels with little or no difficulty.

Marketing of Improved Stoves

3.17 State-run and private sales points. The DSVF has set up one sales station, run by its own staff, in each city. It is intended that these points serve three functions: (a) quality control; (b) stocking centers that can cover demand during promotional campaigns; and (c) supply points for privately run sales outlets (a total of 32 in the four cities). Their performance as sales outlets has been poor, with daily sales averaging no more than two stoves per center. The centers are

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11/ The supply of scrap metal may even diminish in the coming years: major suppliers of scrap metal -- manufacturers of chemicals and soaps are shifting from metal to plastic barrels.

12/ The raw material situation would be less of a constraint, if an improved ceramic stove were successfully marketed. However, the production of ceramic stoves is limited to the region of Zinare, near Ouagadougou. While these stoves have been successfully promoted in this region, there has been little effort to develop a broader-based market for the product.

13/ The blacksmiths do not pay salaries to their employees. Instead, revenues are shared on a 60/40 basis. The DSVF sells "flattened" barrels to the blacksmiths at 2,000 CFAF a piece; on the free market, blacksmiths can obtain non-flattened barrels at 1,250-1,500 CFAF.

14/ At the end of 1988 only 9 out of 32 trained blacksmiths in Ouagadougou were still producing improved metal stoves under the Government-sponsored program.

located too far from the traditional stove markets and the staff lack the skills required to market the product. As an unproductive intermediary, they add to total distribution costs. Quality control could be organized more cheaply and more efficiently through certified controllers trained by IBE, who would visit artisans and provide a seal of approval on well made stoves.

3.18 Itinerant sales. The ESMAP/MET project attempted limited door-to-door sales by private salesmen. The results were encouraging, averaging about 7-8 stoves per salesman per day. With daily sales of six improved stoves per salesman, three itinerant peddlers working 300 days per year could sell more than 5,000 stoves in Ouagadougou, or double the 1988 sales level achieved by the DSVF, using all available sales channels. At the current penetration level of the improved stove, an increase in the number of itinerant salesmen would appear to be a good marketing tool. These salesmen would boost sales up to the point of market saturation. Their presence on the traditional market would heighten visibility of the stove; as increasing numbers of customers purchase an improved stove, those that have refrained from participating to date would feel obliged to do otherwise.

3.19 Marketing techniques. Improved stove promotion activities are executed by the provincial offices of the MET in collaboration with other decentralized ministerial offices and NGOs. Campaigns to promote the **improved 3-stone stove** in rural areas were first undertaken in 1983 as a component of forestry projects. Similar campaigns were carried out in the major cities in 1984 and 1986, but were later abandoned for cost reasons as well as problems associated with their correct construction use and maintenance. 15/ Late in 1984, the improved metal stoves were first promoted among public employees in Ouagadougou; more widespread urban promotion campaigns were then undertaken.

3.20 The MET/DSVF use three marketing instruments: (a) direct sales to government employees; (b) periodic short-term campaigns supported by purchase rebates; and (c) permanent promotion activities. **Direct sales** to the public sector have been the most successful. ESMAP/MET surveys showed that, of total households using a metal stove, one-third had a household head who was either a public employee or military staff. Twenty-two percent of public sector employees have a metal stove, while only 13% of private sector employed households have a metal stove.

3.21 **Permanent promotion** activities are rare. There has been, however, a general use of posters to promote improved metal stoves as wedding gifts and to appeal to a "keeping up with the Jones" notion amongst the population. 16/ The backbone of the DSVF program remains the **short intensive sales campaign**. They were first implemented in Ouagadougou and Bobo-Dioulasso in 1987 and in Koudougou and Ouahigouya in 1988; all were supported by rebates of 40-50%. Future efforts need to reconsider the rationale for this policy, given its impact on the blacksmiths.

15/ *Proper construction maintenance and correct use determine the level of energy savings achieved. According to surveys by the DSVF, only 50-60% of the improved 3-stone stoves are well constructed. The rate of utilization in households having built an improved 3-stone stove varies between 40-80%. The dissemination of the improved 3-stone stove is done by training women trainers in stove construction. The DSVF estimates that around 40,000 people have been trained in construction of the improved 3-stone stove.*

16/ *As part of its campaign, the DSVF has promoted the idea of giving improved stoves as wedding gifts. It would have been interesting to test if IBE's painted metal stoves could find a market for this purpose.*

The subsidy makes sense from the DSVF point of view, since success is measured by the number of stoves sold during the campaign rather than over the length of the program. The rebates have, however, acted as a powerful disincentive to the blacksmiths, who have largely refused to participate, concerned that the stoves will not sell once the rebate period is over.

3.22 These campaigns have other problems. They create a high demand for the improved metal stove during the campaign and a fall in demand immediately thereafter. The traditional system of scrap metal supply copes poorly with bursts in demand and the blacksmiths face cash flow problems in buying larger than usual quantities of scrap metal. These campaigns are also costly. As shown in Table 3.4 below, the cost per unit sold (1,400 CFAF/per stove) is high compared to the retail price of the stove (ranging from 650 CFAF-1,650 CFAF for the **Ouaga metallique** and the **Burkina mixte**. While per unit costs are typically high in the early phases of a marketing campaign, the apparent continuing lack of consumer interest in the stove products several years into the program is a strong signal that the campaign strategy needs to be reconsidered.

Table 3.4: Campaign Costs and Sales

Campaign	Cost (FCFA)	Sale of Stoves	Cost per Stove
Ouagadougou 87	6-7 million	5,000	1,400 FCFA
Bobo-Dioulasso 87	1 million	1,200	830 FCFA
Koudougou 87	1-2 million	1,200	1,000 FCFA
Ouahigouya 87	2 million	300	6,700 FCFA

Source: ESMAP/MET

3.23 Campaign messages. The content of the promotional message used in the Government-sponsored campaigns has also deterred consumers from purchasing the stoves in larger numbers. From the outset of the program, political messages have dominated the campaigns, from raising the environmental consciousness of the population to promoting women's participation in environmental protection. Commercial messages were introduced late into the program but have not yet been anchored in an in-depth understanding of what motivates the consumer to purchase and use the product.

3.24 Monitoring and evaluation. The absence of an adequate monitoring mechanism has deprived the MET of sorely needed information on consumer response to these campaigns. ESMAP/MET surveys showed that the most commonly used marketing techniques (cooking demonstrations in public places, posters, loudspeakers etc.) have failed to convince the consumer that purchasing and using an improved stove would have an impact either on their finances or on their quality of life. ESMAP/MET interviews in Ouagadougou, for example, revealed that the marketplace was a poor locale for stove demonstrations, since women have other pressing tasks to complete and limited time to linger. Once past the initial curiosity, few women stayed to watch and fewer still stayed to learn about the fuel economies. In contrast, demonstrations held in the neighborhoods were well attended. The Ouahigouya promotion campaigns were not successful at all due, in part, to the widespread use of the **improved 3-stone stove** (38% of households), to the relatively low price of fuelwood and to the high level of self-collection of fuelwood. This

information underscores the need for market analyses and for tailoring promotion campaigns to the specific socio-economic and regional characteristics of the individual city.

3.25 Informal sector campaigns. Initiatives in this sector were limited to work on the **Burkido** stove. While limited evidence suggests that other informal sector activities are important consumers of biomass, few sustainable initiatives have been developed. A campaign to promote improved stove use among the street food vendors is, nonetheless, warranted not only because of projected energy savings in this subsector, but because a successful campaign will add to the visibility of the improved woodstoves. Introduction of the "journée continue" has encouraged a flourishing curbside restaurant business that can be expected to grow as the urban population grows and as economic conditions change.

D. Improved Stove Program: Results

3.26 The ESMAP/MET survey of the households in the four major cities in the fall of 1987 showed that urban households own, on average, 2.9 stoves of different types, of which 2.6 are used. The different models are used in the following order of importance:

(a) 59% of households regularly use the **traditional 3-stone stove**;

(b) 40% of households regularly use the traditional metal stove, (the **malgache**);

(c) 25% of households make regular use of, on average, 1.8 **improved 3-stone stoves**;

(d) 14% of households, make use of the **improved metal stoves**. These 15,000 households own a total of 26,000 improved metal stoves, of which 22,000 are used. Two-thirds of these are **Ouaga métallique**, one-third are **Burkina mixte**.

3.27 Penetration by city. Table 3.5 provides information on the rate of market penetration by city. Because of the much higher fuelwood and charcoal prices in Ouagadougou, a priori, it was to be expected that the level of penetration of the improved stoves would be highest there. Similarly, a priori, it would have been natural to conclude that the favorable fuelwood supply situation in Ouahigouya would have occasioned a lower level of improved stove penetration than elsewhere. The actual outcome, however, is more complex as Ouahigouya has the highest penetration rate. However, it is based exclusively on use of the improved 3-stone stoves. Use of improved metal stoves is almost nil in Ouahigouya. In Bobo-Dioulasso, on the other hand, the rate of penetration of improved stoves is a third lower than in Ouagadougou and Koudougou's penetration rate is only half that of Ouagadougou.

Table 3.5: Improved Stoves, Rate of Market Penetration by City, 1987

	Number of households using improved stove	In % of households
Ouagadougou	26,000	39%
Bobo-Dioulasso	8,000	31%
Koudougou	900	14%
Ouahigouya	1,600	50%
TOTAL	36,500	36%

3.28 That 36,000 households, or one-third of the urban population made regular use of an improved stove represents an important achievement for the program. 17/ Since 1988, however, sales have been insufficient to permit a further market penetration of the improved metal stove. In 1988, when the number of urban households grew by 8,900, official sales amounted to 5,000 stoves, of which half were sold in Ouagadougou. Sales outside the government-supported network are not known. Taking into account replacement needs for worn out stoves and that, on average, 1.7 improved metal stoves are used in the household, this level of sales corresponds to less than 3,000 new customers.

3.29 Penetration by income group. Knowing the penetration by consumer category of improved fuelwood stoves is an important management tool for policymakers, because it improves the possibility of targeting the campaigns to specific consumer categories as well as measuring the program's social impact. 18/ Figure 3.1 provides three types of information: (a) the distribution of the total population by income group (% of total), (b) the distribution of improved stove users by income group and (c) the rate of market penetration of improved stoves in each income group (% that uses an improved stove). Income group 1 represents those with incomes less than 20,000 CFAF; group 2 with incomes of 20-49,000 CFAF; group 3 with incomes of 50,000-99,000 CFAF; group 4 with incomes of 100,000-149,000 CFAF and group 5 with incomes over 150,000 CFAF. The largest number of households (40%) as well as the largest number of improved stove users (43%) are found in income group 2. The highest market penetration rate is found in income group 4, where half of the households use an improved stove.

3.30 Figure 3.2 shows that in all income groups, the **improved 3-stone stove** has a higher level of market penetration than any of the two metal stoves --although the combined level of penetration of the metal stoves is higher than the **improved 3-stone stove** in the two highest income categories. This information suggests that, for the overwhelmingly majority of the urban population, the saturation point of the market is far from being reached.

17/ *6,000 households used both the improve metal stove and the improved 3-stone stove.*

18/ *Contrary to many other African cities, the distribution of the urban population by neighborhood in Ouagadougou is relatively homogeneous. This makes it difficult to target the campaigns to specific low-income groups.*

Figure 3.1: Market Penetration of Improved Stoves by Income Group

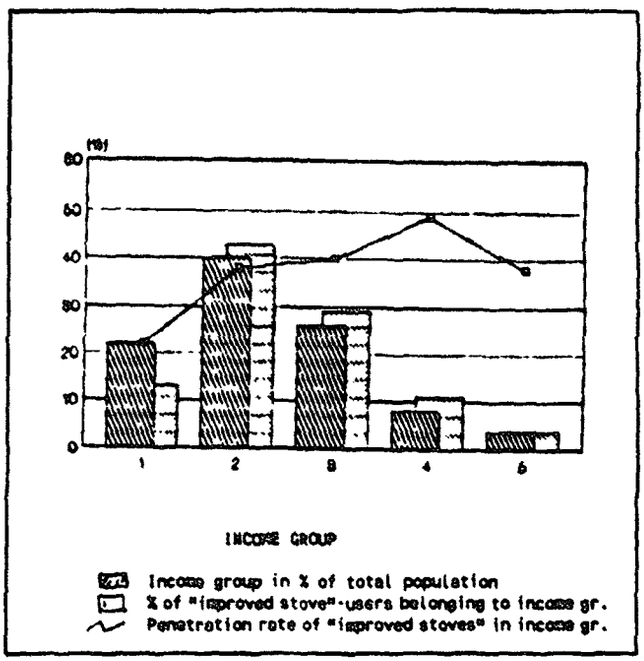
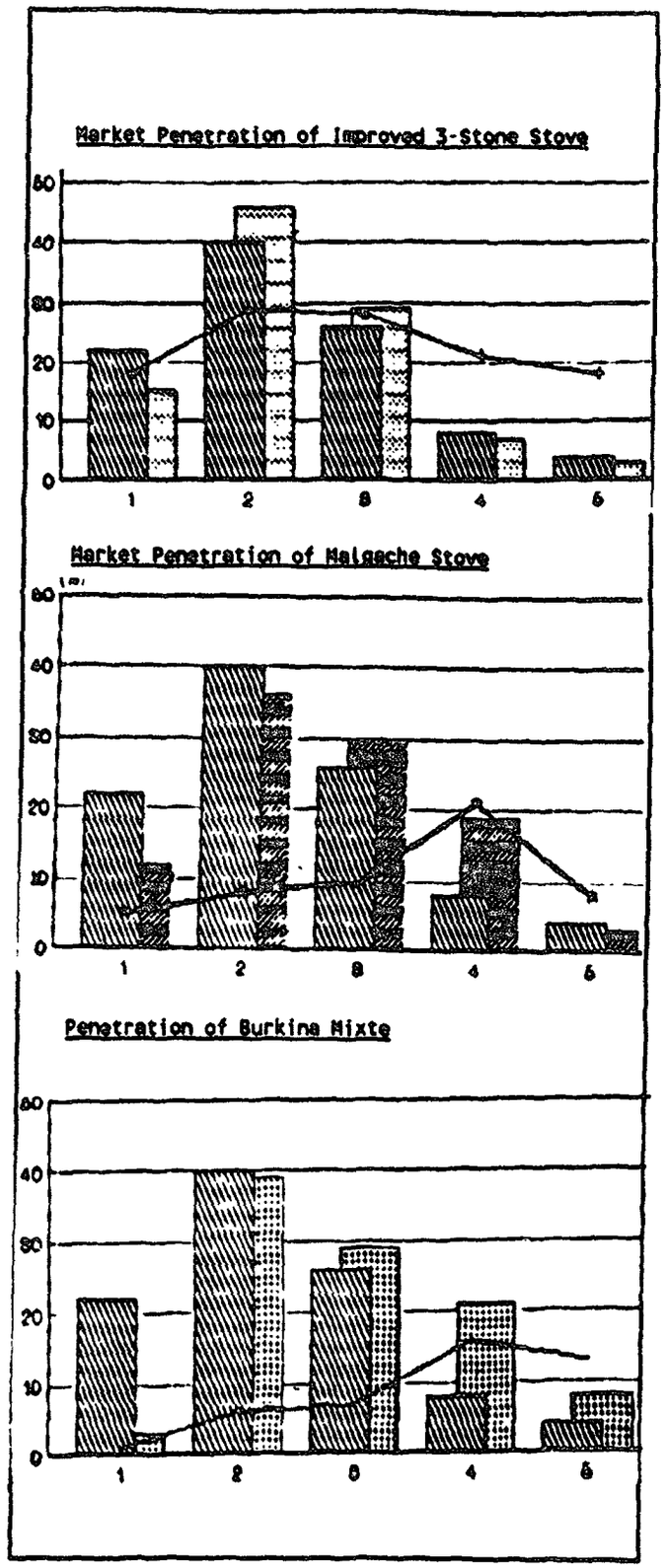


Figure 3.2: Level of Household Income & Penetration of Different Types of Improved Stoves



3.31 Impact on low-income families. Considering the high economic burden of fuelwood expenditures on the low-income household budget, improving welfare through the dissemination of improved stoves is an important government objective. Seen from this perspective, the performance of the improved stove program is a clear disappointment. Three factors can explain the low level of market penetration in the lowest income group: (a) the message on economic advantages of the improved stove either did not reach this group or was unconvincing; (b) the cost of the improved stove is too high (the **Ouaga metallique** is used by 5% of this population; the **Burkina mixte** is hardly used at all.); and (c) women at this income level simply cannot afford to participate in training seminars on constructing the **improved 3-stone stove**. Even the modest cost of material used in construction of the **improved 3-stone stove** could also have been an obstacle. Whether the low penetration of the **improved 3-stone stove** is primarily due to the poor marketing or to the conditions imposed by the extreme poverty of the lowest income group is not known. There is, at the same time, little doubt that future successes will depend, to a large extent, on aggressive marketing techniques tailored to the specific characteristics of this target population and careful monitoring of consumer reactions.

3.32 Impact on informal sector producers. Another social objective of the MET strategy was the generation of income for artisans. From this perspective, the program has also fallen well short of its goal. Present sales levels generate an annual income of about 1,500,000 CFAF, providing a monthly income of about 30,000 CFAF for between 4-5 artisans. Even a marked increase in sales will not permit important income gains to be achieved from this program. Rather policy emphasis should be on removing bottlenecks that inhibit the efficient functioning of the informal production network, on the grounds that this is the most cost effective means of production available.

3.33 Energy savings. Overall household fuelwood demand in the four major cities would have been about 7% higher in 1987, without the introduction of improved stoves. Use of the **improved 3-stone stove** saved about 20,000 tons of fuelwood and the **improved metal stove** saved about 5,000 tons. 19/ If it is assumed that savings amounted to 3,000 tons in 1984, 6,000 tons in 1985, and 10,000 tons in 1986, total fuelwood savings in the urban campaigns amounted to 35,000 tons of fuelwood. While significant, it is not enough. In the absence of an energy saving campaign, urban population growth would have pushed 1987 fuelwood consumption 27% over 1984 consumption levels. Under the most optimistic scenario, the improved stove campaigns reduced this consumption to about 20% over 1984 consumption levels.

3.34 The cost-benefit ratio of the stove program. While its impact on the overall energy balance is modest, the improved stove program has a high economic rate of return. Based on an economic retail cost of fuelwood of 25 CFAF (see Chapter VI), the value of the fuel savings over the 1984-87 period can be estimated at 875 million CFAF (US$ 2.9 million). The total cost of the program, as shown in Table 3.6, is considerably lower. Compared to the cost of the traditional **malgache stove**, the purchase of the 25,000 **improved metal stoves** represented a consumer investment of 29 million CFAF (1,100 CFAF/stove) and 5 million CFAF to build the **improved 3-stone stove** (100 CFAF/stove). The cost of Government's promotion campaigns during the same

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19/ Both figures represent a maximum. The first figure assumes that all the improved 3-stone stoves are correctly built. If, as is suggested in some MET surveys, only half are correctly built, the savings may be about one-third less. Secondly, the 60% utilization rate includes use of improved stoves for pots that are smaller than the pot sizes for which the stoves are designed.

period is conservatively estimated at 11 million CFAF (US$ 37,000). However, this figure does not include the general operating costs of the MET and the IBE associated with the campaigns nor the cost of stove components included in all donor-financed forestry projects. Nonetheless, although the addition of these costs will result in a figure significantly higher that identified in Table 3.6, the overall cost-benefit ratio is likely to remain favorable.

Table 3.6: Benefits and Costs of the Urban Improved Stove Program, 1984-1987

BENEFITS	Fuelwood Savings	
	Tons	Economic value
1984	3,000	75 mill. FCFA
1985	6,000	150 mill. FCFA
1986	10,000	250 mill. FCFA
1987	16,000	400 mill. FCFA
Total	35,000	875 mill. FCFA

COSTS	Units	Investment
Metal stoves	26,000	29 mill. FCFA
Improved 3 stone st.	45,000	5 mill. FCFA
City campaigns		11 mill. FCFA
Indirect financing from forestry projects		n.a.
Associated general operating costs of MET and IBE		n.a.
Total	71,000	45 mill +

Costs: 1984 to 1987
Source: ESMAP/MET

3.35 Future energy savings. If the dissemination strategy shifts towards one anchored in improved understanding of consumer motivations and requirements for household energy, it should be possible to increase the penetration rate of improved stoves to 80% of the households by the year 2000. This would reduce fuelwood consumption in the urban households from the trend-based 770,000 tons to 705,000 tons, assuming that the stoves would be used for 60% of cooking tasks. In the informal sector, a promotional campaign aimed at the **dolotières**, who are relatively few in number, should achieve a penetration rate of more than 15% within the first year; 50% the year thereafter; 80% at the end of the third year and a 90% penetration rate by the end of the fourth year. A 90% penetration rate for the **Burkido** stove in the year 2000 would reduce informal sector fuelwood consumption from the trend-based level of 115,000 tons to 95,000 tons. Total savings from a fine-tuned improved stove program could reduce total consumption by about 84,000 tons in the year 2000.

IV. PROMOTION OF SUBSTITUTE FUELS: LPG AND KEROSENE AND CONSUMPTION OF ELECTRICITY

A. Policy Context

4.1 At current natural and urban growth rates, fuelwood demand in the early years of the next century will be so high that further increases in supply will only be possible with reductions in the resource base. The longer term energy consumption scenario for Burkina Faso is, therefore, one in which LPG and kerosene will have to cover the total increase in urban household energy demand. Government's medium term objective up to the year 2000 must be to efficiently manage this on-going transition. To reach this objective Government must: (a) develop and market technically sound, socially acceptable and affordable kerosene and LPG equipment to the urban population, (b) increase the level of LPG use in LPG-consuming households, and (c) familiarize larger segments of the population with the attractions of these fuels.

4.2 This strategy faces formidable natural obstacles:

(a) Since Burkina Faso has no indigenous hydrocarbon resources nor a refinery, all oil products are imported. Therefore, balance of payments considerations call for moderate substitution policies;

(b) Since Burkina Faso is landlocked, the cost of transport to the distribution centers doubles the coastal cif-price of petroleum imports. As a result, the cost of LPG and kerosene for cooking is uncompetitive compared to fuelwood;

(c) Although the amortized cost of the stove equipment constitutes less than 10% of the annual cost of cooking (see Annex III), acquisition of stoves for the substitute fuels represents a substantial cash flow problem for the average urban consumer.

4.3 Broad penetration of substitute fuels is also constrained by institutional and psychological factors:

(a) Fear of gas and well entrenched cooking habits that have established a preference for the use of fuelwood;

(b) Non-availability on the market of LPG and kerosene stove equipment adapted to preparation of the local cuisine;

(c) Inadequate communication and coordination between the three principal actors: SONABHY; IBE, and the oil companies (Shell, Total and Mobil).

4.4 Notwithstanding these formidable obstacles, the Government created the **Commission for the Promotion of LPG** in 1984. Its mandate was to actively promote LPG use and, to a minor

degree, kerosene, as substitute fuels. 20/ In 1985, it established the national oil company, SONABHY, and gave it the monopoly for the importation and storage of petroleum products. SONABHY assumed responsibility for (a) LPG imports, (b) the operation of bottle filling plants and (c) the administration of promotion campaigns. In addition, SONABHY was made responsible for definition of sector policy. The role of the private oil companies was reduced to that of wholesaler/retailer. The results of these efforts and options for expanding the inter-fuel substitution program are examined in the following paragraphs.

Choice of Substitute Fuels: LPG, Kerosene and Electricity

4.5 As fuels in a substitution strategy, LPG and kerosene each have their relative strengths and weaknesses. A sound fuelwood substitution strategy should, therefore, promote both to widen the choice to the consumer. Worldwide, kerosene has played the role of the intermediate fuel in the fuel transition process, since its lower cost favors it as the "entry level" fuel. On the other hand, the higher comfort and cleanliness of LPG make it the preferred fuel, where high income reduces the significance of the cost and cash flow advantages of kerosene. Therefore, in countries where the population experiences rising incomes, LPG tends to replace kerosene as a cooking fuel.

4.6 In low income countries, kerosene has three attractions as a substitute fuel: (a) Because of the higher infrastructure costs of LPG, the import cost of kerosene on a calorific basis is only two-thirds of the import cost of LPG. 21/ In annual fuel costs, the economy saves 9,000 CFAF (US$ 30) each time a household switches to kerosene instead of LPG, assuming that both households use the fuel exclusively. 22/ (b) The front-end investment in a kerosene stove is about 6,000-7,000 CFAF lower than that for a low-cost LPG stove, because no investment in a bottle is needed. 23/ (c) Kerosene can be bought in any quantity, permitting the consumer to adjust the purchased quantity to his/her cash availability. This is important because about 80% of the consumers buy their fuel(wood) on a daily basis.

4.7 However, the convenience of daily kerosene purchases is costly to the consumer: the small-scale retail price is between 50 and 100% higher than the price at the service station. As a result, while the economic and the financial cost of kerosene at the pump is only 60% of the cost

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20/ *Because of these constraints, LPG consumption was negligeable prior to 1984 and the private oil companies serving the market did little to further its consumption. The private oil companies purchased LPG in bottles (Total, Mobil) and in railroad tankers (the mixed state-private company Burkina & Shell) from the Abidjan refinery and sold it from their gasoline stations.*

21/ *The cost of importing 1 ton of LPG consumption can be estimated at 159,000 CFAF, or 63% of the retail price; the cost of 1 ton of kerosene consumption at 97,000 CFAF or 69% of the retail price. These figures are based on the economic price structure as presented in table 4.2 and the following import ratios for LPG: LPG-ex refinery = 1; import-transport = 0.7; SONABHY operating costs = 0.6; local transport = 0.6. Import ratios for kerosene: Product cost = 1; import-transport = 0.7; security storage = 0.3, SONABHY operating cost = 0.5.*

22/ *Based on an annual LPG consumption of 175 kg.*

23/ *By how much the market will be expanded because of this particular feature is uncertain. The ESMAP/MET consumer acceptability tests showed that at the same 10,000 CFAF price level, consumers found the price of the kerosene stove unacceptable, whereas they found the price of the LPG stove acceptable. Nonetheless, while consumers are willing to pay a premium for LPG use, the lower price will certainly be an important consideration for the low-to-medium income consumer.*

of LPG, their prices are about the same at the small-scale retail level. Thus, for the majority of consumers, kerosene will not be cheaper than LPG, unless ways are found to reduce the retail margin. As the high mark-up of the informal retailer reflects the high acquisition costs and the high transaction costs of small-scale retailing, attempts to enforce lower margins by price controls will be in vain. Instead policymakers should aim to rationalize the structure of distribution, e.g. by using wholesale operated small trucks with tanks that fill kerosene directly into the barrels placed at the retailers.

4.8 Electricity is not used for cooking in Burkina Faso (nor in neighboring countries) and, therefore, does not influence the choice of fuels, with the exception of kerosene which is used for lighting. Compared on a useful calorie basis, present electricity tariffs are four times as high as fuelwood. 24/ Its use is, nonetheless, expanding rapidly. SONABEL's sale of electricity grew by 7.4% in 1986, and the number of clients by 13%, which raised the overall connection rate to 22% of urban households. If this trend continues, the percentage of connected households in the five largest cities will increase to 44% by the year 2000 and urban household demand will increase from 36 GWh to 170 GWh.

B. Substitute Fuels: Infrastructure and Security of Supply

4.9 One of SONABHY's first efforts in support of LPG was to establish a basic infrastructure network and to reduce the cost of imports. The security of supply for substitute fuels is adequate as sufficient sources are available in the region (see Annex IV). LPG can be acquired from the refineries at Abidjan (Cote d'Ivoire) and at Tema (Ghana), the international market or from refineries in the immediate neighboring countries landed at the port of Abidjan or at Lome. With a new refinery at Port Hartcourt, Nigeria can serve as a back-up source of supply. Kerosene can be obtained from (a) Abidjan (local production of the SIR refinery, as well as international imports), (b) international imports through STSL, the ocean oil products receiving terminal in Lome and finally, (c) the GHAIP refinery in Tema as a back-up source of supply.

4.10 With this range of choices, SONABHY follows a lowest-cost source of supply purchase policy, purchasing only marginal volumes as required from higher cost suppliers. Shortly after its establishment, SONABHY redirected LPG imports from the highest cost source of supply (the SIR refinery) to the lowest cost source of supply in region (the Tema refinery), thereby reducing the ex-refinery price by one-half. Kerosene is imported from the international market through the port of Abidjan.

4.11 SONABHY achieved further cost savings and improvements in the security of supply of LPG by investing in an automatic filling station in Bingo (30 km from Ouagadougou) and a bottling plant in Bobo-Dioulasso, both with a storage capacity of 100 tons. Filling capacity at the Bingo depot is 200 * 12.5 kg bottles per hour, i.e., 20 MT per 8 hour day. Current consumption

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24/ *Cost pr. kWh (3.6 MJ) in Ouagadougou in 1987 was 87.8 CFAF. Assuming a 60% efficiency for the electric cooker, this amounts to 40 CFAF/useful MJ. 1 kg of fuelwood (16 MJ) costs 25 CFAF, or at a 14% traditional cooker efficiency, 11 CFAF/useful MJ.*

is 4-5 MT per day. A two-day shift can handle 10 times the current level of consumption, corresponding to 60,000 households switching full time from fuelwood to LPG.

4.12 Transport capacity is sufficient. Eight 20-ton LPG road tankers are owned by six private transport companies. This provides a monthly transport capacity of 320 tons, based on a conservative assumption of two rotations per month 25/; present demand calls for a transport capacity of no more than 140 tons. Road and rail tanker capacity for kerosene is adequate; currently no more than 20% of the combined capacity is being used. 26/ The 1,850 m^3 of kerosene at Bingo and 1,430 m^3 at Bobo-Dioulasso are equivalent to 68 days of consumption, which is more than sufficient to meet both practical and strategic concerns. An expansion of the market of more than 10,000 m^3 per year will be needed to justify additional tankage, corresponding to 50,000 households switching from fuelwood to kerosene for their cooking tasks.

4.13 In contrast to kerosene, increased consumption of LPG will require some added investments over the short term, totalling about 83 million CFAF (US$ 0.275 million): (a) promotion of 3 and 6 kg bottle stoves is a critical element of the Government's LPG promotion strategy and there is, at present, no specialized equipment for filling these bottles at the filling station. 27/ SONABHY will need to install a manual filling line for 3 and 6 kg bottles with a capacity of 700 tons (US$ 25,000). (b) SONABHY is responsible for bottle maintenance and charges the oil companies for its services but has no bottle maintenance and painting facilities. The absence of a maintenance capacity poses a safety hazard. The funds required for a manual painting installation amounts to an estimated 15 million CFAF (US$50,000). (c) Once LPG demand doubles, additional storage capacity at Bingo is needed. Two bullets of 50 tons capacity will cost US$ 100,000 each.

4.14 The size of the bottle park in Burkina Faso is not known with certainty. SONABHY estimates the park at 18,000 12 kg bottles and 6,000 3 kg bottles, sufficient to cover the demand of between 9,600 and 16,000 households. 28/ When demand increases, new bottles will have to be imported at a cost of 229 million CFAF (US$0.76 million) per 1000 tons growth in LPG demand. 29/

25/ *With proper planning, four rotations per month are possible.*

26/ *The fact that truckers continue to add to their fleets when most are only running at 30% of their capacity makes it abundantly clear that the officially mandated transport rates are far in excess of what they should be. An order of magnitude estimate of the excess road transport charge of all petroleum products is US$ 4-5 million/year.*

27/ *Filling is done on a scale, a method which is imprecise and potentially dangerous: The margin is +/- 400 grams. If the bottle is overcharged, it can be deformed when exposed to direct sunlight entailing a risk of explosion.*

28/ *The rule of thumb for a smooth distribution is 2.5 bottles per customer; for bottom line distribution 1.5 bottles per customer.*

29/ *Assumptions: Average annual rotation rate of 6 times for the 12 kg bottles and of 8 for the 3 kg and the 6 kg bottles; and a 25/37.5/37.5 distribution of future increases in sales volume among the three. For each 1000 ton growth in LPG demand, Burkina Faso needs to import 3,500 12 kg bottles at a cost of 12.9 million CFAF (US$ 43,000) per 1000 bottles; 17,000 3 kg bottles at a cost of 6.7 million CFAF (US$ 22,000) per 1000 bottles; and 7,800 6 kg bottles at a cost of 9 million CFAF (US$ 30,000) per 1000 bottles.*

Stove Equipment

4.15 LPG stoves. To make LPG more accessible to the lower/middle income consumer, the mixed private/Government oil company Burkina & Shell introduced 3 kg bottle/stoves (the "Faitou N'Bora") in 1985. 30/ The stove offered three advantages: (a) the initial cash outlay is about 60% of the cost of the most inexpensive 12 kg stove set, as depicted in Table 4.1; (b) the financial outlay for the LPG refills is about one-fourth; and (c) the stove is more portable, a consideration for the lower income household without a car. However, the "Faitou N'Bora" is ill suited for the lengthy cooking tasks of the Burkinabe diet, restricting its utility from the outset to marginal cooking tasks; data show that only 20% of the cooking tasks in LPG-consuming households are performed on LPG equipment. 31/

Table 4.1: Cost of Investment in 3 kg and 12 kg LPG Stoves in CFAF

12 kg LPG stove		3 kg LPG stove	
Bottle	12,500	Bottle	7,000
Regulator	3,740	Burner	3,415
Hose	1,750	Support	2,950
LPG	4,125	LPG	907
Appliance	5,000		
TOTAL	27,115		16,107

4.16 IBE subsequently developed a prototype for a domestically produced, highly energy efficient, low-cost LPG stove, adapted to local conditions; it can be connected to 3 kg, 6 kg or 12 kg bottles via a tube and a depressurizer. It is expected that the stove will be ready for production during 1990. The 1988 ESMAP/MET pilot consumer acceptability test revealed that the majority of the households found the stove appropriate (8 out of 10), fast (7) beautiful (6) and would like to buy it (8). Only a minority (2) considered the suggested price of 10,000 CFAF too high. 32/ IBE also tested a stove for 3 kg and 6 kg bottles developed as part of an upcoming EEC-financed regional LPG project. The stove is adapted to the requirements of the local cuisine and the support can be produced locally. The production price will be some 2000 CFAF higher than for the "Faitou N'Bora".

30/ *Some other less successful stoves were marketed as well.*

31/ *The same is true for the 12 kg bottle-based equipment. However, this equipment was targeted for a higher income population with a different and lighter cuisine,. making it more suitable for their cooking needs. The lack of price competitiveness of LPG begs the question whether the structure of LPG consumption in LPG consuming households would have been different if a stove suitable for local cooking needs had been available on the market. It may well be that, under unchanged relative prices, the "Faitou N'Bora" is perfectly adequate for marginal LPG consumers.*

32/ *However, it is not clear whether the households were aware that the cost of the LPG bottle, 7,000 CFAF for a 3 kg bottle had to be added. IBE expects that the cost of manufacturing the LPG stove will be somewhere between 5,000 and 6,000 CFAF in mass production. The cost of the depressurizer and the rubber hose, (about 3,500 CFAF) plus a retail margin must be added.*

4.17 Kerosene stoves. **Kerosene** stoves marketed in Burkina Faso are small Chinese wick models costing between 4,000-6,000 CFAF. They are light, but incompatible with the spheric pots used in Burkinabe cuisine and with lengthy cooking times. IBE, in the meantime, has developed a gravity fed kerosene burner which is simple in design, achieves 50% efficiency, can fulfill the demands of Bukinabe cuisine and is suitable for local production. The market prospects for this model, which probably will cost around 10,000 CFAF, should be promising. An ESMAP/MET consumer acceptability test of an imported kerosene model undertaken in December 1988 revealed a generally positive attitude towards this kerosene stove, although the price was considered to be too high. 33/

C. Marketing LPG and Kerosene

4.18 SONABHY has not yet developed a successful marketing concept. The only campaign to promote LPG dates back to 1985, when the Government launched a **private sector-based** program with the oil companies, in particular, with Burkina & Shell. The strategy had four components: (a) removing distribution bottlenecks, by allowing new imports of bottles and raising the consignment charge of the LPG bottles to parity with full purchase cost. 34/ (b) reducing the initial access cost to LPG by introducing new low cost, direct pressure stoves based on the 3 kg bottles and eliminating import taxes on this low-cost LPG equipment. 35/ (c) launching a promotion campaign including direct sales to employees of state institutions and private enterprises. (d) introducing a credit system for public sector employees, where repayments were made through deduction at source. 36/

4.19 With the creation of SONABHY, a **Government-controlled system** was put in place, which discouraged the private sector's interest in LPG promotion for both real and for psychological reasons. SONABHY overlooked the tradeoffs between efficiency objectives and competitive/ entrepreneurial objectives in LPG marketing: (a) SONABHY began importing and bottling LPG because it felt that the Burkinabe market was too small to justify the establishment of bottling

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33/ *Of the 10 households, 8 found that the stove was fast; 6 that it was clean; 6 that the taste of the meal did not change compared to use of fuelwood; and 4 quoted the absence of smoke as an advantage. 6 were interested in acquiring the stove, but 7 out of 8 found that the proposed price of 10,000 CFAF was too high; and 5 found that the consumption of kerosene was too high.*

34/ *The oil companies either sell the bottle to the consumer or charge the consumer a deposit (consignment charge). Usually, the deposit price is set at full cost recovery. The advantage of the full cost deposit policy compared to a sales policy is that, in many countries, the oil company can write off amortization of the bottles against taxable income. To reduce the initial investment cost, the oil companies in Burkina Faso - as in many other African countries - initially tried to market the bottles at below cost. The result worked against the objective of LPG promotion. Because of higher consignment charges in neighboring countries, the bottle park was depleted as the bottles crossed the border, creating supply bottlenecks. In 1985, the consignment charge was set at full purchase cost and the trend was reversed. With the opening of the bottling plant in Bingo, the rotation of the bottle park was also increased. With these two measures the supply bottleneck disappeared.*

35/ *The Government also reduced taxes on LPG by 75% without, however, changing the retail price.*

36/ *The credit system, administered by Burkina & Shell, helped to promote sales among public sector employees. However, its administration proved to be difficult and the oil company lost some 1.5 million CFAF on non-recovered loans.*

plants operated by competing oil companies; and that if only one oil company operated a bottling plant, an undesired monopoly position was created. As a result, however, if a private company now engages in LPG promotion, the benefits of increased consumer demand are now split between the oil companies (revenues from retailing and wholesaling) and SONABHY (revenues from bottling and importing). (b) In order to provide an incentive to the oil companies to engage in promotion campaigns, the LPG price structure provided for a contribution to a fund for financing promotion campaigns (3% of retail price). This fund is administered by SONABHY, and private oil companies have to apply for funding on the basis of prepared campaign proposals. The oil companies, however, consider this an unnecessary bureaucratic intervention in their functions. (c) In order to rationalize the operation of the bottling plant and the distribution system, SONABHY introduced a system of single-colored bottles. Customers could, as a consequence, turn in any bottle to any dealer. This policy, however, undercuts the trademark orientation of the promotion strategies of private oil companies, which is based on their own distinctively colored bottles and their specific equipment.

4.20 The limited market provided the oil companies with few incentives to develop a broad-based **retail network**. Burkina & Shell sells LPG in 3 kg bottles only at its gasoline stations (8 in the larger Ouagadougou area); apart from 3-4 stove retailers there are no other sales outlets for its "Faitou N'Bora" stove. Any strategy in favor of promoting LPG on a large scale must improve the availability of the fuel through an increase in retail outlets.

4.21 The same lack of coordination is apparent in IBE's stove development program, which has been undertaken without any consultation with the oil companies which would be responsible for marketing. 37/ A producer willing to manufacture the new domestic stove models has not been identified.

Structure of LPG and Kerosene Prices

4.22 Successful LPG and kerosene promotion requires a price structure providing **margins** that are adequate to allow the agents to fulfill their market functions - no more and no less. A margin that is set too high goes against the goal of keeping the consumer price low and may lead to over-investment. A margin that is too low leads to under-investment and under-provision of services and of infrastructure. The size of the **Government take** should be determined by an evaluation of the trade-offs between (a) Government revenue requirements; (b) the attainment of energy policy objectives, and (c) equity considerations.

4.23 The uncertainties regarding the proper roles of the different LPG actors are reflected in the official LPG and kerosene price structures adopted after the creation of SONABHY in 1985. First, LPG and kerosene prices are uncompetitive with fuelwood. The price of imports is high and the Government take adds a third to the price. Second, the rationale of the price structure is weak. The official price structures of LPG and of kerosene are presented in Annex V and are summarized

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37/ *Burkina & Shell, the only company that has made a serious effort to market LPG stoves, still has a stock of 5000 "Faitou N'Bora" stoves left from its campaign. As long as this stock has not been drawn down, Burkina & Shell is not interested in promoting any new stove.*

in Table 4.2 below; proposed revisions to the price structure are also presented and discussed in Chapter VII. 38/

Table 4.2: Price Structures of LPG and Kerosene
CFAF/metric ton for LPG
per hectoliter for kerosene a/

	LPG		Kerosene	
	actual	proposed	actual	proposed
1) Product ex Tema (Lome)	75,000	75,000	78,000	60,000
2) Transport to Bingo	85,000	70,000	42,852	36,000
3) Government Take				
- Stabilization Fund	28,424	0	19,876	0
- hidden stab.in line 1	(20,000)	0	18,000	0
- Tax take, line 7 (9)	12,874	0	11,800	0
- Promotion Fund	10,000	0		
- Security Storage	20,000	0	9,228 b/	9,228
4) SONABHY's operating costs(l. 9-12+15)	27,058	70,000	18,240 c/	18,240
5) Distributors' Costs				
- Transp. Bingo-Ouaga	6,000	18,000		
- Wholesalers' margin	31,640	23,500	12,000	11,100
6) Retailers' margin	34,000	15,500	7,400	
Retail price per kg (l.)	330	272	160	113 c/

a/ 1 ton of kerosene = 1256 liters.
b/ Lines 10,12 13,17,19,21 in Annex V.
c/ Lines 14-16,18,20,22-25 in Annex V.

4.24 The market distortions in the LPG price structure are identified as follows: (a) The line for the cost of LPG ex-refinery should provide the **importer** with incentives to seek the lowest cost source of supply. However, because of the price stabilization fund, there is no incentive for rational import behavior: if the purchase is higher than the fixed price, the fund will reimburse the difference; if the purchase price is lower, the difference will be paid into the fund. The fact that the price set for LPG purchased ex-Tema is about CFAF 20,000 higher than present market prices is felt more by the final consumer than by the importer. (b) The **transport** costs from the refinery to the bottling plant are overestimated. The margin was set at a time when Government wanted to strengthen its petroleum transportation capability. The unfortunate result of this too successful policy has been a fleet that is twice as large as needed. 39/ (c) The direct plus indirect **Government take** (including a price ex-Tema that is higher than the normal rate) is high, equivalent to the ex-refinery cost of the fuels. (d) The margins that are set to cover SONABHY's operating costs for the **bottling plant** are too low. (e) The **wholesalers' cost** of transporting LPG bottles to and from Ouagadougou to the bottling plant is underestimated. (f) The **retailers' margin** is set at more than 10% of the retail price, which is higher than the normal 6% found in the West African

38/ *The lowest cost supply option is depicted for each fuel, i.e. for LPG the ex-Tema structure is analyzed and for kerosene the ex-Lome structure is examined.*

39/ *The trucks are now averaging less than 2 turnarounds per month rather than a normal 4.*

region. This increases the consumer price more than necessary. More importantly, it goes against the objective of creating as many retail outlets as possible, because the high retail margin provides an incentive for the wholesaler to take over the retailing function. As a consequence, the oil companies have restricted the LPG retail points to their own service stations.

D. LPG and Kerosene Use: Program Results

4.25 National targets. The 1990 objective of the 1986-90 Five-Year Plan was to have 32,000 urban households using an LPG stove and to reach an annual consumption of LPG of 4,800 tons. Because of the absence of a marketing strategy, these objectives will not be reached. After a spurt in demand during 1986-87, demand has stagnated. 40/ LPG demand in Burkinabe households (expatriates excluded) is no higher than 600-700 tons, equivalent to a replacement of no more than 4,000 to 5,000 tons of fuelwood.

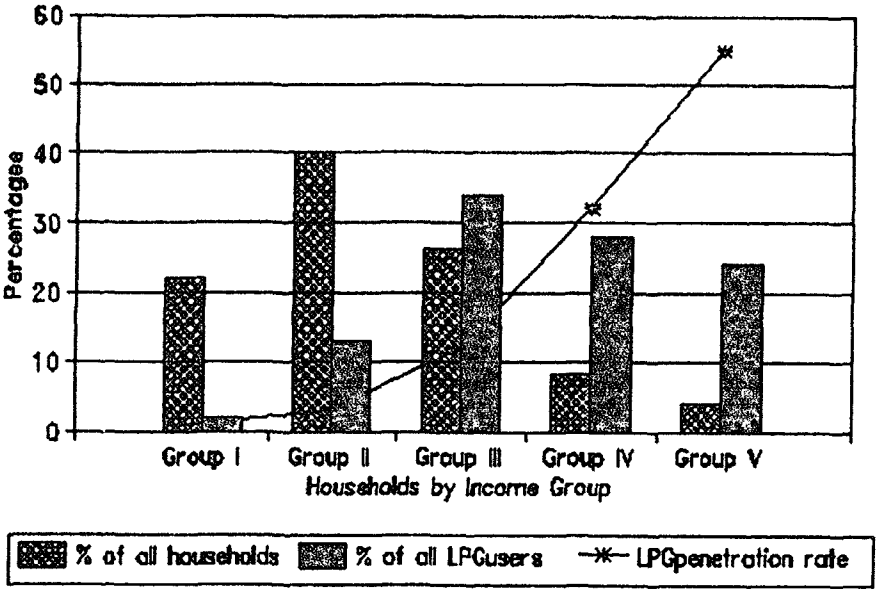
4.26 Household use of LPG and kerosene. About 9% of urban households, or 9,200 have an **LPG stove**. The average consumption of fuelwood in LPG-using households is 60% of the consumption in households using the **traditional 3-stone stove**. LPG households that use LPG as their primary fuel continue to rely on fuelwood for some 27% of their cooking tasks. Households that use LPG as their secondary fuel rely on fuelwood for over 80% of their fuel needs. Ownership of **kerosene stoves**, found in 4% of urban households, seems to have no, or little effect on fuelwood and charcoal consumption; this would suggest that the kerosene stoves on the market are poorly suited to local cooking requirements.

4.27 The **captive market for LPG** is made up of the richest 12% of urban households belonging to the two highest income categories (see Figure 4.1). 41/ About half of these households have acquired an LPG stove. At this income level, availability of LPG is the only concern. LPG use is not so much restricted because of its price but rather because the female head of the household will not entrust the use of the LPG stove to the servant who does the cooking.

40/ The doubling in volume was primarily due to: the real demand in 1982-85 was artificially suppressed because of the lack of availability of LPG; Government had launched a campaign convince civil servants to switch to gas and introduced a small low-cost stoves on the market; and the number of expatriates increased.

41/ Group I = <20,000 CFAF; Group II = 20-49,000 CFAF; Group III = 50-99,000 CFAF; Group Iv = 100,000-149,000 CFAF; Group V = >150,000.

Figure 4.1: Penetration of LPG Use by Income Group
Urban Households in 1987



4.28 The **two poorest income categories fall largely outside the market for LPG**. Hardly any LPG stoves are found in the poorest 22% of households with a monthly income of less than 20,000 CFAF. Among the 40% of households with monthly incomes of 20,000 to 49,000 CFAF, only 3% possess an LPG stove. Without a significant change in relative fuel prices, it is doubtful that a penetration rate higher than 10% can be reached, **even if** an active promotion campaign were undertaken. The prospect of increasing the use of substitute fuels within this group depends on the marketing of a suitable kerosene stove. The future marginal market for LPG must be found, therefore, within the **middle income group**, or the 27% of households with monthly incomes ranging between 50,000-90,000 CFAF. According to ESMAP/MET data, only 12% of these households own an LPG stove.

4.29 Penetration of low-cost stoves. As the promotion campaign for the 3 kg bottles was short-lived, the introduction of the low-cost LPG equipment did not have a significant impact on LPG consumption. Most of the LPG-consuming households (74%) use the 12 kg bottles only; some 9% use both the 12 kg and the 3 kg bottles and the remaining 17% use 3 kg bottles only. The relative shares of household LPG consumption are 85% for the 12 kg bottle and 15% for the 3 kg bottle.

4.30 Geographic penetration. The **geographic concentration of the promotion campaign** on Ouagadougou has created little demand in the other three major urban centers. The rate of market penetration by city is a function of average household income and the intensity of the campaign. The highest rate was found in Banfora, where 20% of the households owned an LPG stove in 1988. A number of the country's most important industries are found in this city, providing its residents with the highest per capita income. 42/ The next highest level of LPG penetration was found in

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42/ *It is this factor rather than any Government policy or campaign that accounts for the level of LPG use: Shell & Burkina supplies mostly the hotels, while households obtain their 3 kg, 6 kg and 12 kg bottles delivered from Abidjan.*

Ouagadougou, where 12% of the households own an LPG stove; LPG use in Ouahigouya is insignificant. Because of the relative size of the urban centers, however, Ouagadougou accounts for 76% of total LPG consumption, Bobo-Dioulasso and Banfora for about 11% each, and Koudougou and Ouahigouya for the remaining 2-3%.

E. Inter-fuel Substitution: Medium and Longer Term Prospects

4.31 The year 2000. It is probable that population growth will accelerate demand for LPG and kerosene during the 1990's. In the absence of an aggressive promotion campaign and changes in the relative price structures, it is, nonetheless, unlikely that demand would climb much beyond the current rate of 9% of urban households using LPG and 4% of urban households using kerosene. Given current trends, it can be expected that some 29,000 households would consume about 2,000 tons of LPG 43/ and some 13,000 households would consume about 550 tons of kerosene for cooking purposes.

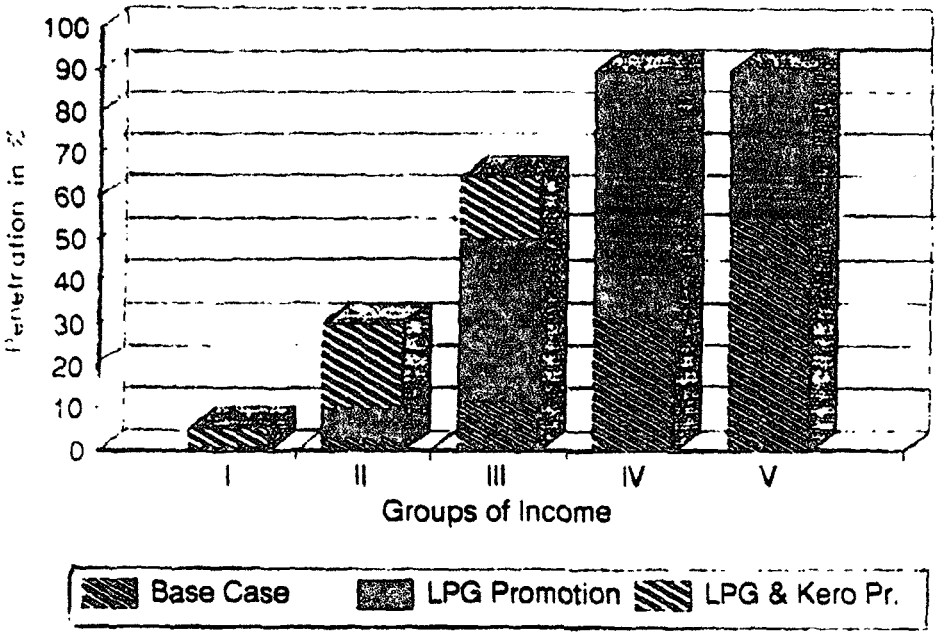
4.32 The rate of fuelwood substitution of a well-implemented LPG promotion strategy along the lines proposed in Chapter VII will depend on both the penetration rate of the stoves as well as on the level of their use in LPG-using households. Presently, only 39% of LPG-consuming households use LPG as their primary fuel. This percentage will not change significantly by the year 2000, 44/ as LPG will remain more expensive than fuelwood, even after a reduction of the Government take to zero. Nor should it be necessary to achieve a higher rate of use, since sufficient fuelwood resources should be available to cover urban demand until that time. Through aggressive marketing, a substitution program based on LPG only, should be able to increase the penetration rate from 9% to about 28% of households in the five largest cities. This will increase household LPG consumption to 8,600 tons.

4.33 The introduction of an adequate kerosene stove supported by an aggressive promotion campaign could increase the fuel substitution market to 41% of urban households, 17% kerosene-consuming households and 24% LPG-consuming households. While in the year 2000, kerosene consumption for cooking will increase to 6,000 tons, LPG demand falls only to about 7,300 tons, as most of the gains of kerosene promotion are expected to occur in the lower income groups (see Figure 4.2). The assumptions for these scenarios in the year 2000 are set out in Annex VI.

43/ *Total demand including demand from industry and services will likely be somewhere between 3,500-6,000 tons.*

44/ *That more suitable LPG stoves are introduced will induce a higher rate of stove purchase. It will not, however, by itself, lead to a higher average level of fuel consumption in the LPG households. While the new consumers will have a more energy intensive structure of food consumption, they will be poorer and will be very price sensitive in their selection of fuels.*

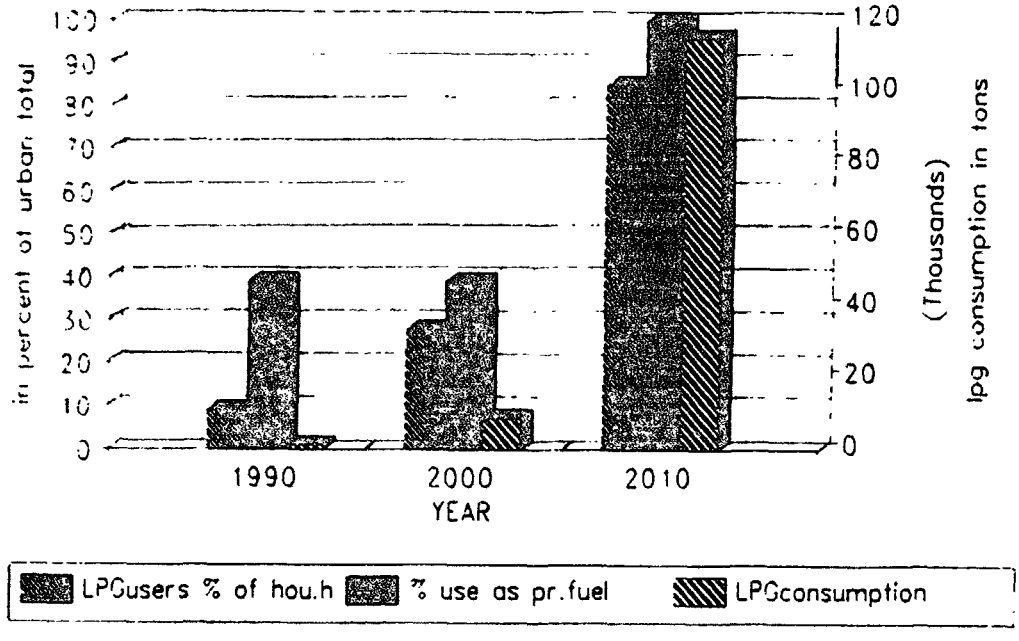
Figure 4.2: LPG and Kerosene Use by Income Group



4.34 The year 2010. The real challenge to policymakers will come at the turn of the century or shortly thereafter. The urban population will continue to grow at a level twice that of the overall growth rate. However, increases in the supply of fuelwood to meet urban household energy demand will not be possible without reductions in the resource base. Presently, LPG consumers using LPG as their primary fuel continue to rely on fuelwood for about 27% of their cooking tasks. If this level remains unchanged, it will be possible, by the year 2010, to keep urban fuelwood demand at the year 2000 level, if two conditions are fulfilled: (a) the rate of penetration of substitute fuels must increase from 41% to 85% of total urban households and (b) all LPG and kerosene-consuming households must use these modern fuels as their primary fuel.

4.35 Under this scenario, urban household energy consumption during the next decade must switch from one that is woodfuel-based to one that is LPG and kerosene-based. By the year 2010, about 650,000 urban households should be consuming LPG and kerosene as their primary cooking fuel. As shown in Figure 4.3 below, this will lead to an LPG consumption level of between 65,000 and 115,000 tons, depending on the level of kerosene penetration.

Figure 4.3: LPG Penetration Ratios and Consumption Levels needed for Sustainable Demand



Switching to Fuelwood Substitutes: Economic Implications

4.36 The calculation of the economic value of fuelwood substitution by LPG or by kerosene is set out in Annex VII. Based on a comparison of the direct economic costs of fuelwood and of LPG, the **economic value per ton promoted LPG** is negative: **-77,000 CFAF** (US$ 256) and leads to an **increase in imports** of **141,000 CFAF** (US$ 470). 45/

4.37 It is unlikely that the environmental benefits of the standing forest cover are so high that their inclusion in the economic cost comparison will change this conclusion. Under these circumstances, the switch to modern fuels must be viewed as an unavoidable consequence of population pressure on limited natural resources. The fuelwood substitution strategy proposed in this report will lead to an annual import cost of LPG and of kerosene for cooking purposes in the year 2000 of about 1.7 billion CFAF (US$ 5.8 million); and in the year 2010 of 15.8 billion CFAF (US$ 53 million). Provided that Burkina Faso's overall imports grow at the same rate as the rate of population, the import bill for cooking fuels will amount to 0.7% of total imports in 2000, and to 4.5% in 2010. While it is recognized that the switch to substitute fuels will be expensive, the price of substitution, which is inevitable in light of current population trends, will be even higher if Government continues in its present course. Under any scenario, and given the country's development constraints the reality is that, early in the next century, energy for all will be more expensive.

45/ *Hypothesis: economic retail cost per ton of LPG of 252,000 CFAF and of fuelwood of 25,000 CFAF; a substitution ratio of 1 ton of LPG = 7 tons of fuelwood. Import content of LPG = 63%, of fuelwood = 10%. See also page 29, footnote 28 for calculation of foreign exchange component.*

V. MANAGING HOUSEHOLD ENERGY DEMAND: THE IMPACT OF PRICING POLICIES

A. Policy Context

5.1 Objectives. Pricing policy should promote a rational structure of energy demand and supply by providing both consumers and producers with the correct pricing signals. In Burkina Faso, the price signals to the consumers should discourage wasteful consumption of energy and reduce the demand for fuelwood to a sustainable level. 46/ The price signals to the producers should promote rational management of forestry resources thereby increasing rural employment and provide incentives to the producers and distributors of LPG and kerosene to invest in marketing campaigns and expand the distribution system. In addition, pricing policy should consider income distribution concerns and the need to generate Government revenues.

5.2 Policy features and issues. The Government administers prices for a range of mass consumption products, including fuels. The Ministry of Commerce sets petroleum product prices. The Ministries of Commerce and of Environment and Tourism are jointly responsible for setting wood and charcoal prices. The present price structure was adopted in 1985, when the Government acted simultaneously on three different price fronts to support its energy policy objectives: it raised the official price of fuelwood; it lowered the price of scrap metal for improved woodstoves; and it revised the LPG price structure.

5.3 How these reforms affect the structure of relative prices and thus the demand side, the rate of fuelwood substitution and the demand for improved stoves, will be addressed below. The impact on Government revenue is also examined. How pricing policy impacts on the supply side was discussed in the analysis of the price structure for LPG and for kerosene in Chapter IV. Chapter VI will discuss these impacts as they relate to fuelwood.

B. Pricing Policy: Issues and Options

5.4 Pricing policy options are limited by two obstacles: the poverty of the overwhelming majority of the population and the country's landlocked position:

(a) The basic needs aspect of fuelwood and the high burden of fuel expenditures on low income households constrain the potential scope for energy saving pricing policies. The impact on fuelwood demand of a substantial increase in fuelwood prices will be modest, unless there is widespread fuel switching. Even if fuel switching is achieved,

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46/ *Level of accessible natural production plus fuelwood harvested from the clearing of land.*

the brunt of the policy will be on the urban poor who cannot afford an LPG stove and would have difficulty purchasing a kerosene stove.

(b) The long distances from ports of entry and foreign refineries to Ouagadougou double the FOB price of LPG and kerosene. Few possibilities exist for savings in the transport and distribution chain. Therefore, the market price of substitute fuels is and will remain high.

Government Revenues

5.5 Fuelwood. The official price of fuelwood was set at a retail price equivalent of 18 CFAF/kg in 1985 and the supply system to the cities was reorganized. While implementation fell short of fixed targets, prices did, indeed, rise: from about 15 to about 25 CFAF/kg in Ouagadougou and to 20 CFAF/kg in Bobo-Dioulasso and to about 15 CFAF/kg in Koudougou and Ouahigouya. Government fees--cutting permits of 300 CFAF/stère plus transport permits (300 CFAF per haul) amount to about 1.5 CFAF/kg, or a tax take of between 6% (Ouagadougou) and 10% (other cities). These fees are enforced on a minor but increasing share of total supplies: In 1985, 31 million CFAF (US$ 104,000) was collected; in 1986, 122 million CFAF (US$ 407,000) was collected; and in 1988, cost recovery reached 167 million CFAF (US$ 557,000), or about half of total commercial supplies. 47/

5.6 Charcoal. There is no official price structure for charcoal, because the level of consumption is relatively low, and because a large portion of the supply is recovered from the combustion of fuelwood during the preparation of the traditional **dolo** beer. The retail price is highest in Ouagadougou at 89 CFAF/kg; 48 CFAF/kg in Bobo-Dioulasso, 38 CFAF/kg in Ouahigouya and 28 CFAF/kg in Koudougou.

5.7 LPG. The price of LPG has remained unchanged at 330 CFAF/kg since 1981, although a new price structure was adopted in 1985 that reduced the import tax from 36,000 CFAF/per ton to 9,000 CFAF/per ton. In 1985, total Government revenues (taxes plus the contributions to the different state-administered funds - promotion fund, security stock, price stabilization fund) was 71,000 CFAF/per ton, or 22% of the total. The fall in the purchase price at the Ghana refinery added 23,000 CFAF/per ton to the Government take in 1985, bringing the total percentage up to 32%. With a 1987 consumption of 1,476 tons, total Government revenues (SONABHY surplus included) amounted to 107 million CFAF (US$ 357,000). Although consumption stagnated in 1988, the fall in import prices increased Government revenues to 156 million CFAF (US$ 520,000). In 1989, rehabilitation work at the Tema refinery in Ghana forced SONABHY to once more increase its purchases from the high-cost source of supply, the SIR refinery in Abidjan (140,000 CFAF per ton, in 1990 negociated downward to 100,000 CFAF per ton in 1990).

47/ *100% enforcement of the taxes should have contributed around 340 million CFAF;, 275 million from cutting permits and 65 million from transport permits.*

5.8 Kerosene. The official price at the pump is 160 CFAF/liter. Consumers, however, pay 1.25-1.5 times more for the small quantities they buy at the retail outlets. How much of this markup represents real economic costs in small-scale retailing and how much reflects monopoly pricing is difficult to judge. All that can be said is that the same situation is found in some of the neighboring countries. Government revenues in 1985 (taxes plus contributions to the price stabilization fund) amounted to 34,000 CFAF/m^3 or 21% of the official retail price. The 1985 fall in import prices added 17,000 CFAF/m^3 increasing Government's share to a total of 32% of the official retail price. With a 1987 consumption of 14,000 m^3, total Government revenues amounted to 595 million CFAF (US$ 2 million).

5.9 Total 1987 Government revenues from LPG, kerosene, and fuelwood in 1987 amounted to 869 million CFAF (US$ 2.9 million), representing 1.1% of total Government revenues--a small, but not insignificant contribution. It is evident from Table 5.1 that taxation policy has not been used as an instrument to promote fuelwood substitution, but rather to capture revenue from modern fuels. These fuels are taxed 14 to 19 times higher per toe than fuelwood (or 6 to 8 times higher based on a "useful energy" content).

Table 5.1: Taxation of Household Fuels, 1987

	Revenue mill CFAF	Toe	Commercial Consumption in ton	Tax in CFAF/toe
Fuelwood				
- actual recovery	167	249,000 t a/	95,000	1,490
- 100% recovery	340	249,000 t a/	95,000	3,571
LPG	107	1,476 t	1,565	68,000
Kerosene	595	14,000 m^3	11,400	52,000

a/ Level of total consumption minus 15% for self-collection.

Source: ESMAP/MET 1987

5.10 Development in real prices. Time series data on fuelwood prices do not exist. Nonetheless, indications are that real prices doubled during the 1970s. During the 1980's, consumer prices were stable, 48/ and nominal fuelwood prices did not change until Government's intervention in 1985. Since then, the nominal price of fuelwood has dropped slightly, but so have average consumer prices, leaving the real price unchanged. The nominal price of kerosene and of LPG has remained unchanged since 1981, implying a 15% fall in real prices up to 1987/88.

Relative Fuel Prices

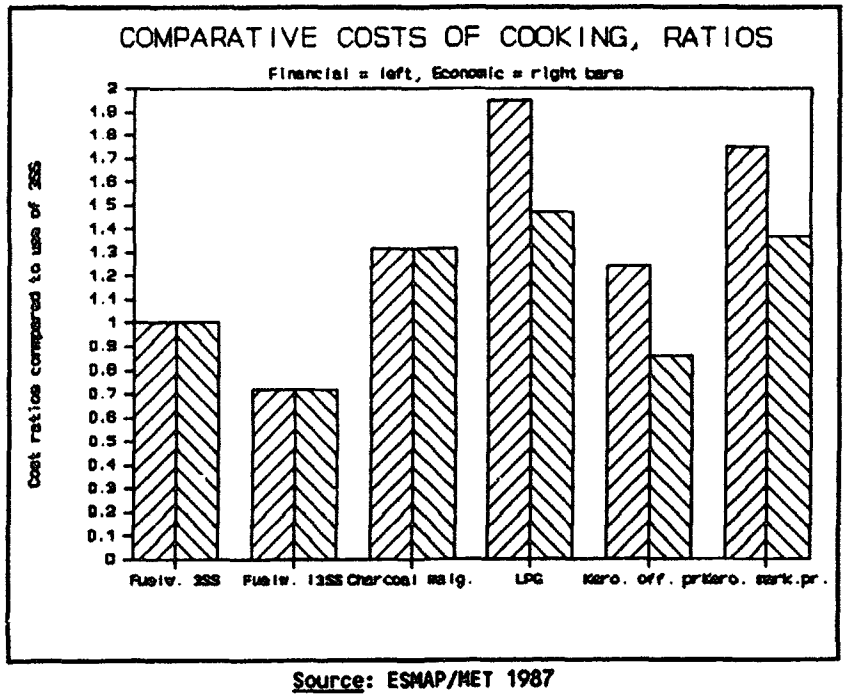
5.11 The relative price of charcoal to fuelwood differs between the cities, being 3.2 times as high on a kilo basis in Ouagadougou, and 2.0 in Koudougou; on a MJ-basis, the corresponding relative prices are 1.8 and 1.1. Charcoal is used for marginal purposes only, but if the low relative

48/ *The index for African consumer prices in Ouagadougou rose from 100 in 1981/82 to 125 in 1985 and dropped to 117 in 1987.*

price in Koudougou becomes a permanent phenomenon, charcoal will start to replace fuelwood in this city.

5.12 The comparative costs of cooking, based on current fuel prices in Ouagadougou are summarized in Figure 5.1. 49/ The figure shows that, although Government's pricing policy has moved in the right direction, the price difference between fuelwood and its substitutes is too large to encourage large scale substitution:

Figure 5.1: Relative Economic and Financial Costs of Cooking
By Type of Fuel and Stove.
Ratio "3-stove=1", Ouagadougou 1987



Source: ESMAP/MET 1987

(a) **Kerosene** is the cheapest fuel at the official price of 160 CFAF/liter. When used with the energy-efficient IBE prototype stove, it is about 1.24 times as expensive as the cost of using the **traditional 3-stone stove** (including the stove amortization costs). At the actual price of 240 CFAF/liter, charged to the small domestic consumer, kerosene is 1.54 times as expensive. If the IBE kerosene stove meets consumer acceptance, consumer prices of kerosene will have to be reduced in order for kerosene too make inroads as a substitute fuel.

49/ *The project financed cooking and boiling tests at the IBE to establish the specific energy consumption of a Burkinabe household using stoves available in the country. Based on the assumption of an energy efficiency of 14% for the traditional 3-stone model, the user efficiencies for the other stoves have been calculated based on actual performance.*

(b) **LPG** is also too expensive compared to fuelwood to gain an important share of the urban cooking fuel market: depending on the stove model, the fuel cost is 1.8 (IBE prototype model) to 2.3 times (Shell's "Faitou N'Bora") as high as the cost of cooking on the **traditional 3-stone stove.** Even though LPG provides more comfort, this premium is too high to attract the mass consumer.

5.13 The market share of the substitute fuels will also depend on the success of the **improved wood stoves.** If they attain widespread use and are correctly utilized, the economic attractiveness to the consumer of the substitute fuels will be further undermined: The present cost of using LPG or kerosene is about three times as high as the cost of using fuelwood in the improved woodstoves for sale on the Burkinabe market.

5.14 Due to high production costs, **electricity** tariffs all but exclude electricity as a substitute fuel for cooking. 50/ Assuming a 60% efficiency for an electric cooker, electricity in Ouagadougou is three to four times as high as the cost of fuelwood used in a traditional 3-stone stove-even without taking into account the amortized cost of the stove.

Policy Trade-Offs

5.15 To promote fuelwood substitution, Government will have to change relative prices by (a) lowering the official price of LPG and of kerosene or (b) increasing the price of fuelwood, or (c) doing a combination of both. The decision will largely depend on a political choice among the issues of (i) fuelwood substitution, (ii) equity, and (iii) revenue generation. 51/ A policy of increased taxes on fuelwood will increase Government revenues and impact heavily on the lowest income groups, whilst simultaneously providing further economic opportunities for some high-income groups:

(a) Low-income households spend between 15 and 25% of their budget on fuelwood. The financial ability of the poorest households to acquire improved woodstoves as a means to mitigate the impact of higher fuelwood prices is limited.

(b) If the tax rates can only be enforced on a minor share of total fuelwood supplies, the higher fuelwood prices will increase the profits of the well-to-do transporters/ wholesalers who control the market.

5.16 A reduction in the taxes on kerosene would benefit the poorer sections of the population, as kerosene is widely used as a fuel for lighting purposes. But because kerosene is a mass consumption good, and because a tax reduction on kerosene cannot be applied in a discriminatory manner, it would lead to a relative high loss of Government revenue; it would also

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50/ *SONABEL's rates for "lifeline tariffs" vary from 50.9 CFAF/kWh in Ouagadougou to 64.8 CFAF in Fada N'Gourma. The normal tariff for lighting, the relevant tariff for cooking costs, varies between 76.4 CFAF in Fada N'Gourma and 90.7 CFAF in Debougou and is 87.8 CFAF in Ouagadougou. The quoted tariffs are taken from the average sales prices listed in SONABEL, Rapport d'Activité 1986.*

51/ *The fourth issue concerns the minimization of "free rider" effects i.e. any subsidy program that cannot be restricted to the "incremental" or additional consumers, will be a free gift to those consumers who would have also acquired the good in the absence of the subsidy.*

subsidize a large number of consumers who would have purchased the kerosene even without a reduction in taxes.

5.17 This is not the case for LPG because LPG is used by a small percentage of the population and because the tax decrease can be applied in a discriminatory manner. LPG is conditioned in different sized containers (bulk; 55 kg; 35 kg; 12 kg; 6 kg; and 3 kg cylinders), which are linked to different types of equipment. This limits the cross price elasticity of demand between the consumer categories. Therefore, as long as the price difference compared to the 12 kg cylinders does not become too large, a tax decrease can be limited to LPG conditioned in 3 and 6 kg bottles that are the most economic means of entry to low and middle income consumers. Since taxation takes place at the point of delivery from the bottling plants, there are no administrative problems associated with this policy. Compared to an "across-the-board" tax decrease, the wealth benefit accruing to the upper income groups and the loss in Government revenue will be lower.

C. The Impact of Economic Pricing on Inter-Fuel Substitution

5.18 By eliminating the direct and indirect tax take on LPG and kerosene and by adjusting the official price structure to reduce margins that induce inefficient operations, the official price of kerosene can be reduced by 47 CFAF per liter and the price of LPG by 58 CFAF per kg. Although the differences in the absolute level of prices are reduced, the ranking of fuels by their relative price structure is not altered by the introduction of economic prices:

(a) applying the official retailers' margin, use of a kerosene stove is 14% cheaper than use of the 3-stone stove when bought directly from the gas station. However, assuming that the additional mark-up in small retail shops will remain unchanged, kerosene-based cooking would be 37% more expensive than that of the 3-stone stove.

(b) LPG cooking on the low-cost LPG stove, the "Faitou N'Bora", would still be about 80% more expensive than the use of the 3-stone stove, and using the more efficient IBE prototype, about 47% more expensive.

5.19 These results suggest that changing present policy to one reflecting actual economic prices would leave the demand of the majority of urban consumers unaffected. The substitution impact would be limited to the middle-to-high income consumers, (about 25% of the urban consumers). In order to gradually introduce LPG and kerosene as a cooking fuel to a wider segment of the population during the 1990s, Government will have no choice but to adjust prices accordingly. Nonetheless, given the high cost of modern fuels in a landlocked country like Burkina Faso, this policy alone is insufficient to promote a sustainable level of fuelwood demand.

5.20 Introducing subsidies for the substitute fuels or raising taxes on fuelwood are not viable alternatives over the medium term:

(a) With limited financial resources, subsidizing consumption will deprive the economy of vitally needed resources for investment.

(b) The possibility of financing the subsidy by an increase in the taxation of gasoline does not change the substance of the argument, for the tax increase could have been used for other purposes as well.

(c) The argument that the cost of the subsidy should be compared to investments that the Government saves in tree planting to replace the trees that are cut down has more validity to it. However, as analyzed in Chapter VI, the resource base, in principle, is sufficient to cover the demand up to the year 2000 in a sustainable manner, as long as forest management techniques are introduced; wood cut from agricultural land clearing is available for household energy consumption purposes; and changes in land tenure are put in place.

(d) Raising fuelwood prices beyond its economic price is clearly not an option since its impact on the poorer population would be too severe.

5.21 Over the longer term, i.e. shortly after the year 2000, consumption of substitute fuels must increase sufficiently to cap the overall demand for fuelwood. A scenario for a pricing framework which is sustainable over the long term is described in Annex VIII. At that time, Government will have to decide on the desired policy mix of increasing fuelwood taxes and introducing subsidies for LPG consumption. Until that time, the large-scale introduction of sustainable forestry management practices is key to improving household welfare and preserving the natural resource base.

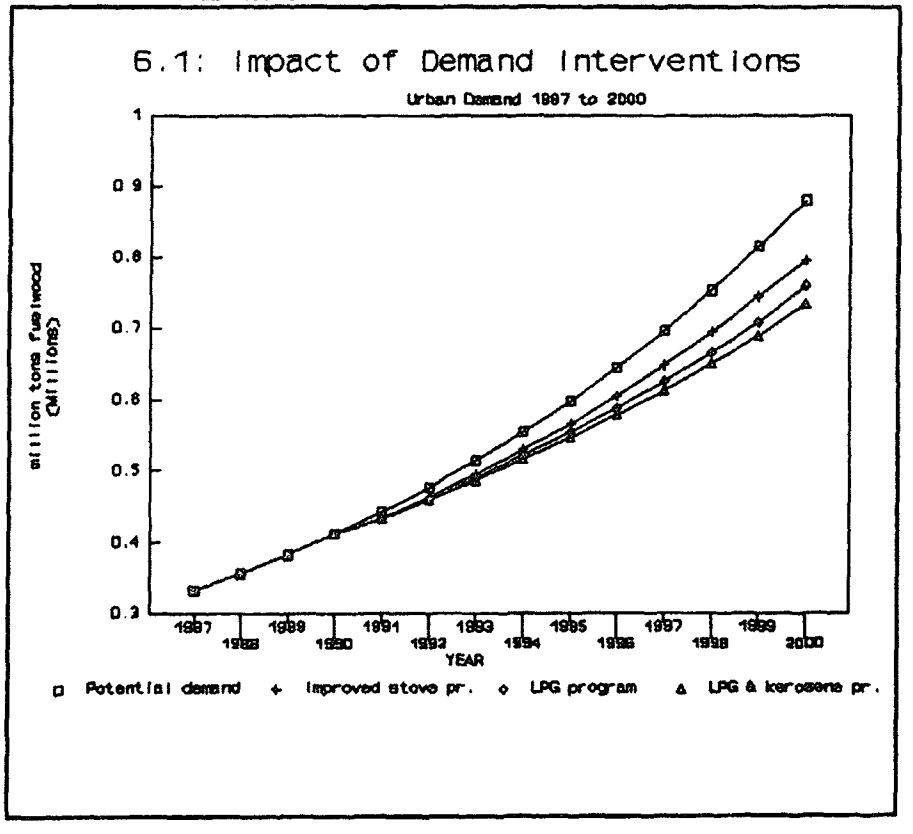
VI. SUPPLY MANAGEMENT OF FUELWOOD

A. The Importance of Forestry Management

6.1 The previous chapters examined the demand for household energy in Burkina Faso, the impact of projected national and urban growth trends on that demand and the performance of Government's household energy strategy. A scenario was then outlined to manage the transition from biomass to modern fuels through demand-side interventions. This alternative, which combines wood conservation measures with fuel substitution possibilities, would aim to reach a penetration rate of 80% for improved woodfuel stoves and penetration rates of 24% and 17% respectively for LGP and kerosene stoves in the urban sector.

6.2 Figure 6.1 depicts this alternative and shows that the implementation of successful demand-side interventions could reduce the projected urban fuelwood consumption (about 900,000 tons) by about 145,000 tons in the year 2000. Nonetheless, the forestry sector must still increase the supply of fuelwood to the urban areas by over 313,000 tons of fuelwood, or 70% of the projected increase in fuelwood demand, to accomodate a near tripling of demand between 1989-2000. Whereas demand-side interventions dominated the previous Plan period, and will continue to be important, future policy must clearly accelerate and strengthen the introduction and use of modern forestry management practices to secure this supply.

Figure 6.1: Impact of Demand Interventions



6.3 The magnitude of this requirement demands a well coordinated natural forestry management strategy at the central level and conservation and protection measures on the part of the rural population. Some pilot experiments at natural forest management are in the very early stages in Burkina Faso and are beginning to show promising results. The sources of fuelwood supply for Burkina Faso's urban areas, the potential for this resource to satisfy the demand requirements, and the options for managing supply over the medium and longer term to meet this demand need to be evaluated for the major urban centers so that these natural forest management experiments can be replicated on a large scale.

The Urban Supply System

6.4 Economic activity. In 1987, the supply of fuelwood to urban areas provided a **turnover** of about 5 billion CFAF (US$ 17 million), not including the value of self-collection. Total **employment** across the fuel chain was about 8,000 man-years, of which some 2,600 in woodharvesting; 1,500 in transport and wholesaling activities and the remaining 4,000 in the fuelwood retailing. Because of the prevalence of part-time work, the total number of persons working in the sector is likely to be between 20,000-30,000.

6.5 The increase in fuelwood demand by the year 2000 and the introduction of forestry management plans will increase employment to some 25,000 man-years; depending on the pressure on fuelwood prices, annual turnover will be around 20 billion CFAF (US$ 68 million). Charcoal is still a marginal fuel in urban households, and most of the supply is recovered from fuelwood used to produce **dolo** beer and in household use. But the experience elsewhere in the Sahel suggests that demand for charcoal can rapidly increase, if left uncontrolled.

6.6 Existing sources of supply. The predominant source of fuelwood for the urban centers is the natural woodlands; most comes from unmanaged forests, from natural wood regeneration on fallow land and from degraded, but naturally wooded, non-agricultural lands. 52/ Each of the four major urban centers gets most of its fuelwood within a 100 km radius of the city. About half of the wood comes from distances within a 50 km radius and is transported by foot, bicycle, donkey cart and pick-up. Because of the manner in which this wood supply enters the city, the quantities and sources of origin are more difficult to pinpoint. It is, nonetheless, apparent that this wood is of smaller dimension than wood coming from longer distances and is cut green. The remainder comes from areas beyond 50 km and arrives by truck and pickup. With the exception of Bobo-Dioulasso, the bulk of this material has been coming from dead trees that succumbed to the 1982-1984 drought. As the source of drought-killed trees nears exhaustion, the wood is increasingly coming from land clearing practices that are largely uncontrolled. As a consequence, a considerable portion of the felled wood that could be used for fuelwood is probably destroyed.

6.7 Land clearing is not allowed on **public domain lands** "domaine classe" - national forests, parks, reserves and ranches. It is, however, accelerating, fueled by the lack of knowledge of forestry boundaries; the lack of enforcement, the search for farm land; and internal migratory

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52/ *About 8% of Ouagadougou's supply comes from forest plantations.*

patterns that bring squatters from degraded lands in search of new opportunities. 53/ The **principal cause** of forest cover loss has been and remains land clearing for agriculture, concentrated, in particular, on lands previously uninhabitable due to river blindness. Mapping work carried out under the ESMAP activity indicates that most of the national forests and reserves have been partially **cleared for agriculture** by illegal squatters. How much of the cleared wood is used as fuelwood for the rural and urban areas and how much is burned is unknown. The potential annual supply of fuelwood from this source is about 288,000 tons (total urban fuelwood demand=330,000 tons) and will increase to 350,000 tons by the year 2000. 54/ Given current and projected growth trends and their impact on the supply of woodfuels, an essential element of any supply strategy must be to secure access to as much of this fuelwood as possible.

6.8 Many of the forests and other national lands have never had their limits marked on the ground with permanent boundary markers. Local villages and even provincial foresters often do not know where the forest boundaries are located. The status of some public domain lands within the onchocerciasis-freed areas being developed for agriculture is particularly unclear. For example, part of the White Volta National Forest was cleared and agricultural villages created, but the MET has no record of this forest being partially or completely declassified for development.

6.9 Fuelwood production options. The creation of new **industrial scale fuelwood plantations** has nearly ceased due to high costs and low productivity. Under present free access conditions of fuel harvesting, the net-back value of fuelwood (consumer price minus costs of retailing, wholesaling, transport) is far below the stumpage fee of approximately 15 CFAF/kg, that is needed to sustain this operation. The other tested option, the **"village woodland"** formula, which relies on shared work for shared benefits on common land, has proven to be an elusive goal. In those areas where trees are needed, there is usually not enough real common land to achieve adequate impact.

6.10 The predominance of natural forests for present fuelwood supply indicates a potential for increasing fuelwood production through **natural forest management**: virtually all the local trees and shrub species coppice readily when cut live. Even modest gains in sustainable productivity could have significant impact on fuelwood supply. The principles of a viable natural forest management system are being tested in an ongoing FAO-assisted project at the Nazinon National Forest in the woodfuel supply zone of Ouagadougou. Since its start-up in 1988, some 20 forest management cooperatives with about 500 members have been directly involved in the management of 22,000 hectares. Ten other groups have been created and are cutting dead wood on **domaine protege** (state) lands in another area; there are plans to bring a large contiguous block of 20,000 ha. of natural forest land under management in this area.

53/ *The return to the farmer of growing agricultural crops on cleared forest lands is 4 to 8 times as high as the return on natural forest management per ha.*

54/ *The present area under cultivation is about 2,000,000 hectares. If it is assumed that annual land clearing equals the growth of the rural population, cultivated area should increase by 1.8% per year, or 36,000 hectares. Assuming that the cleared forest area has a density of 12.5 m^3 per ha. of which 80% is usable for fuelwood, and assuming a weight density of 0.8, a figure of 288,000 tons is obtained.*

6.11 Present Government Strategy. The Government has a three-pronged approach to achieving a sustainable supply of fuelwood over the long run. The strategy aims first to reduce the uncontrolled exploitation of forest resources through a system of licensing and registration of woodcutters, transporter/wholesalers and retailers; they are being organized in cooperatives and economic interest groups. Fees for fuelwood cutting and for transport permits were increased and a system of control put in place, which markedly increased revenues from this activity. A new price structure was adopted that increased the producer price to a level which, in principle, provides for management of this resource.

6.12 The second element of Government's strategy, parts of which are under implementation, provides for the testing of alternative forestry management techniques and for the mapping of existing and potential areas of fuelwood supply within each urban supply zone; the latter activity was carried out under the ESMAP study. The final element of Government's strategy, yet to be implemented, is the designation of specific zones in which to form woodland management cooperatives and the launching of large scale forestry management operations.

6.13 Present legislation. Government has recognized the need to control the exploitation of its forest resources and has instituted an array of regulations and mechanisms to address this issue. It is clear, however, from the plethora of decrees and circulars covering the fuelwood trade that a number of anomalies exist, e.g. apparent overlap or unclear allocation of authority and responsibility of ministries and other public agencies at national and local levels; unclear rights and obligations of the main actors in the fuelwood trade, e.g. transporters and woodcutters. In the absence of clear operational directives, these laws are frequently implemented and/or interpreted in various ways by local authorities, creating confusion and further complicating a rapidly evolving situation. Tenure arrangements for access to and preservation of biomass resources at the level of rural households and communities are not now adequately addressed but figure prominently in the approaches being designed under the Village Land Management Program. Annex IX provides a list of the relevant legal texts.

Pricing

6.14 The MET and the Ministry of Commerce are jointly responsible for setting and monitoring the fuelwood price structure. The price is set and controlled at the producer, wholesale and retail levels. The official price structure is defined per **stère** at the producer and wholesale levels and per "fagot" at the retail level. The two measures are not well-defined. In principle, the **stère** is defined as 1 m3 stacked. 55/ The price structure assumes that one **stère** is split into 36 bundles (**fagots**). In practice, the size of the **fagot** varies with the market price for wood, whereas the price of 120 CFAF per fagot is respected. The ESMAP/MET market weighings in 1987 showed one **fagot** to average 4.5 kgs in Ouagadougou and 8 kgs in the other three cities; i.e., a **stère** of 250 kgs was split into 58 and 36 **fagots** respectively.

55/ *In Burkina Faso, a stère is generally one third to one half less. With a density of 0.8, 1 solid m^3 should weigh 800 kgs. However, it is normally assumed in Burkina Faso that 1 stère weighs 250 kgs. Assuming that 1 stère is equal to 1 m^3, has a density of 0.8 and weighs 250 kgs, we arrive at a conversion factor for stacked m^3/solid m^3 of 0.31. However, experiments in other countries have shown conversion factors of 0.31 for a headload of branchwood, and of 0.5 (for crooked wood) to 0.65 for stacked wood.*

6.15 In 1985, the Government adopted a nationwide system of uniform prices. It did not take into account the geographic differences in the productivity of native woodlands; the existence and location of forest stands; the state of the transportation infrastructure; demand variations due to regional populations; or adjustments for quality differences. 56/ Table 6.1 shows that the Government was able to enforce the producer price, but not the wholesale and retail margins in the Ouagadougou area. This was because the reorganization of the fuelwood supply network favoured the attempted increase in the producer price, while making compliance with the wholesale and retail prices more difficult: (a) the bargaining position of woodcutter cooperatives is stronger than the position of individual producers; (b) restrictions on woodfuel transport strengthened the monopoly position of the transporters and enhanced their ability to defend their economic interests.

Table 6.1: Official and Actual Structure of Fuelwood Prices (CFAF/stère)

	Ouagadougou		Bobo-Dioulasso		Ouahigouya	
	offic.	actual a/	offic.	actual	offic.	actual
Cutting Permit	300	300	300	300	300	300
Producers margin	1,310	810	1,250	n.a.	500	500
Transp/Wholes.m.	2,065	4,015	950	n.a.	1,100	n.a.
Retailers margin	645	1,775	645	n.a.	300	n.a.
Retail price b/	4,320	6,900	3,145	3,600	2,100	3,500

a/ ESMAP, IBE, MET survey 1986.
b/ Calculated at official retail price for one fagot = 120 and 1 stère = 1 m^3 = 36 fagots.

6.16 The system of uniform prices was subsequently dropped when monitoring revealed substantial deviations from posted prices: for example, the high level of demand in Ouagadougou combined with restrictions transport resulted in a market price that is about 40% higher than Koudougou, although their supply zones overlap. Similarly, while the Ouahigouya supply zone is poorly endowed with wood resources, the high level of self-collection keeps an effective lid on the price. Price revisions reduced the margins and costs for the transporters/wholesalers in Ouahigouya, Bobo-Dioulasso and Banfora. The producer price was reduced to 800 CFAF/stère in Ouahigouya, reflecting the official view that consumers were either unwilling or unable to afford correspondingly higher retail prices. The logic of this view is doubtful; actual market prices in Ouahigouya are some 60% higher than the newly posted price.

6.17 Government's pricing and taxation policy should: (a) promote natural forest management practices; (b) encourage the use of wood from land clearing for fuelwood and discourage the supply of fuelwood from non-managed sources; (c) raise producer prices from managed fuelwood resources to their full long-run economic cost; (d) differentiate cutting permits by applying a lower rate to "managed" fuelwood and including the forestry service's administrative

56/ *Officially, the price cannot be increased when the fuelwood is of above quality because of its species composition. Nor can it be lowered when the quality is lower. Secondly, the producer who sells only large dimension wood receives the same price officially as the one who splits his wood into more usable size.*

costs in that rate and applying a higher rate to "unmanaged" fuelwood equal to its full stumpage value (i.e. the replacement cost); and (e) encourage transporters to seek new sources of supply through a system of variable rates for transport permits.

6.18 Table 6.2 below sets out a price structure that moves the existing price structure towards one that accounts for the cost of forest management. The original price structure defined in 1985 is shown for comparison. The cost of labor is based on the noted productivity of 2 stères of fuelwood per day and the official minimum wage rate of 990 CFAF. 57/ The cost of natural forest management is as yet unknown. In the FAO-assisted project, the contribution to the management fund has been set at 500 CFAF per stère. The cost of 200 CFAF for the cooperative's administrative expenses and 700 CFAF for the wood splitting are based on actual experience. Adding together the cutting permit fee (which is likely to correspond to the forestry service's cost of administration and technical support to the cooperatives), the contribution to the management and administrative funds, the **stumpage fee amounts to 1000 CFAF/stère or 4 CFAF/kg.** 58/

Table 6.2: Proposed Fuelwood Price Structure (CFAF/stère)

	Proposed	1985-st.
Cutting permit	300	300
Management fund	500	n.e.
Administration	200	n.e.
Labor	500	990
Entrepreneurial margin (30%)	150	322
Producer price	**1,650**	**1,612**
Transport permit	20 a/	300
Transport costs	1,500	749
Handling	345	345
Salaries	53	53
Taxes	6	6
Margin (20% of above costs)	715	613
Wholesale price	**4,299**	**3,678**
Splitting	700	600
Taxes	2	2
Margin (20% of above costs)	1,000	856
Retail price	**6,001**	**5,136**

a/ Based on 15 stères capacity 7-ton truck.

57/ *This is higher than the normally found rural wage of 600 CFAF/day, but reflects the fact that forest management demands new skills development and training of the workers.*

58/ *Strictly speaking, this is the economic cost of "sustainable supply" rather than the marginal economic cost of fuelwood produced by forest management. The above calculation attributes the total production to the impact of forest management. This is not correct as natural regeneration would have produced an important amount of fuelwood by itself. Thus, in principle, the investment in forest management should have been related to the increase in production only in order to arrive at the real economic cost of fuelwood produced by forest management. However, in practice, what we need to know is at what economic price sustained production becomes viable. Because of the peculiar characteristics of natural forest management, a stumpage value of 4 CFAF/kg is sufficient to bring the production to the market. The "true" and higher stumpage value is of more theoretical interest.*

6.19 Transport costs of transport (fixed costs and operating costs) should reflect the marginal cost of supply. 59/ It has been calculated for a second-hand truck which picks up fuelwood in a supply zone 100 kms from the demand center on a combination of paved road, unpaved road and improved dirt road. The transport permit of 300 CFAF is per trip, not per capacity; a truck pays no more than a cart. As such, the permit covers the Government's administration costs and also more heavily taxes fuelwood coming from within a 50 km radius; this wood is generally transported by headload, cart and pick-up.

6.20 In the revised price structure, the retail margin is slightly higher than the original estimate. 60/ Assuming that 1 stère = 250 kgs, this retail price gives an economic cost of supply of about 24 CFAF/kg, 61/ somewhat lower than the 28 CFAF/kg market price in Ouagadougou, but higher than the market price in the other four cities. It can be concluded, therefore, that the consumer faces the correct market signals in Ouagadougou, the main urban fuelwood market.

B. A Strategy for Natural Forest Management

6.21 Objectives. The goal of any forest management operation is the sustainable provision of goods and services from the forest area. In the case of Burkina Faso, these goods and services include (depending on the specific site being managed): fuelwood, poles, rustic timber for the household, forage, medicines, gums, game meat and other minor but important products for the rural population. Even modest gains in sustainable productivity could have significant impact on fuelwood supply. Preliminary data emerging from very limited trials suggest that the costs may be as little as US$200/hectare to restore and rehabilitate the productive potential of even fairly degraded forest areas. These costs would be less if fuelwood harvesting were carried out so as to foster natural regeneration of these stands. 62/

6.22 Assessing available and potential supply. Given projected urban growth rates together with the meager fuelwood savings generated by the national improved stove program, the ESMAP activity attached high priority to identifying existing and potential supply of fuelwood within the supply zones of the four major centers and developing strategies to preserve and protect this natural resource. The only major forest inventory work for Burkina Faso was carried out between 1980-1983, based on 1975-1976 satellite imagery now badly out of date. A rapid reconnaissance survey carried out by ESMAP/MET on transects southeast, south and southwest

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59/ *The original price structure used an average cost estimate to calculate the transporters' margin on the assumption that transporters would earn sometimes more and sometimes less than real costs. This is not realistic; if the transport cost is higher than the margin, the transporter will either force the producer to accept a lower price or refuse to go there.*

60/ *The margin in the original 1985 cost study is higher than the margin finally adopted in the price structure: the first was based on 1 stère = 42 fagots, the second on 1 stère = 36 fagots.*

61/ *The 24 CFAF, being based on supply from managed land provides the lower boundary for the economic cost of supply; the upper boundary is 35 CFAF based on a stumpage value of plantation fuelwood of 15 CFAF.*

62/ *This must be compared to the relatively high cost of large-scale reforestation, for example, the approximately 350,000 CFAF/ha (about US$ 1,000) experienced at the Gonse area west of Ouagadougou*

of Ouagadougou together with comparisons with earlier inventory data corroborated the dramatic changes that were taking place in forest cover and land use. A full-scale forest inventory was considered beyond the scope of the ESMAP activity both for cost reasons as well as for the need to rapidly introduce forest management practices and mobilize popular participation for their implementation.

6.23 An inventory, with estimates of the production potential of each city's fuelwood supply zone was considered essential to determine priority areas for initiating forestry management activities. Interpretation of satellite imagery combined with selected ground-truthing was used to prepare new cover maps for the supply zones. Three forest cover maps (Ouagadougou/Koudougou, Bobo-Dioulasso and Ouahigouya) were produced from early dry season 1987 satellite imagery at a scale of 1:500,000. Ouagadougou and Koudougou were mapped together, because their supply zones overlap. The present wood supply zone for each city was mapped together with potential supply areas that may be developed within the next 5-10 years. The extension of the mapping into potential supply zones gave priority to areas with significant natural forest cover remaining, to areas accessible by major roads, and to areas classified as national forests (where tenure arrangements are clear).

6.24 A classification scheme, based on the relative importance of the areal coverage of fields and recent fallows versus the natural vegetation types (natural forests and old fallows) was developed and is set out in Table 6.3. Using estimates of standing volume, average annual growth and average fuelwood density, annual productivity estimates for the three major cover types for the 4 main urban centers were made and are shown in Table 6.4.

6.25 Selection criteria for forestry management zones. To make choices regarding areas for developing natural resource management schemes, criteria were established to rank areas within the supply zones of the urban centers. Those priority zones can and must be updated and improved as additional information and experience in natural forest management is acquired. The selection criteria are set out below by decreasing importance:

(a) minimization of transport costs;

(b) priority to national forests;

(c) priority to larger blocks of uninhabited woodlands;

(d) priority to the management of forests on soils/sites that are ill suited to agriculture;

(e) priority to forests in good condition.

6.26 Based on the mapping exercise and using the selection criteria listed above, ESMAP/MET identified priority areas for the introduction of natural forest management capable of yielding about 630,000 tons of sustainable fuelwood production in the year 2000, as shown in Table 6.4. About 41% of the supply will come from the management of natural forests (N), 39%

from low density agricultural land with at least 50% of the land in natural forest (F), and the remaining 20% from medium density agricultural land with 10 to 50% covered by natural forest and old fallows (M).

6.27 In principle, this amount of fuelwood should be sufficient to cover urban demand by the year 2000. However, some qualifications have to be added. First, this level of production is based on the level of production in the individual priority sites within the supply zones that will be reached at the end of a 15 year management cycle. That is, if all the priority projects were implemented today, which, obviously, they will not, the production is reached in the year 2005. Second, it assumes that the fuelwood coming from land clearing can, indeed, be recovered. Current practices suggest that this assumption is dubious.

Urban Fuelwood Supply Strategies

6.28 Annex X provides a detailed description of the urban supply strategies for Ouagadougou/Koudougou, Bobo-Dioulasso, and Ouahigouya and outlines priority areas for natural forest management within each zone. Hypothetical productivity scenarios for priority zones are also included. The salient features of these strategies are described below.

6.29 Ouagadougou/Koudougou. ESMAP/MET estimated total fuelwood consumption in 1987 at 151,710 tons. Based on current per capita rates of fuelwood consumption (0.622 kg/per person/per day, Tables 6.5 and 6.6 projects fuelwood demand for Ouagadougou and Koudougou through the year 2000. The tables illustrate fuelwood use scenarios under three population growth rates. The importance of reliable estimates of the base population and the annual growth estimates are underscored by these figures. From the year 1990 to 2000, fuelwood demand in Ouagadougou, grows by 93% under the low growth scenario, but if the high estimates are used, demand jumps by more than 171%.

6.30 Estimates indicate that the Ouagadougou-Koudougou supply zone has about 5.8 million tons of standing volume in commercial fuelwood species. This growing stock is on 1.5 million hectares of N, F, and M class lands. Annual growth, or the amount of wood potentially available for fuelwood removal on these lands, is estimated for the year 2000 at 514,000 tons, an amount barely sufficient to satisfy the two cities' needs under average population growth assumptions for that year. Land clearing by that date, however, is liable to have eliminated significant amounts of the remaining natural forest land. Although there is still some potential for Ouagadougou to continue to expand its supply zone beyond the area mapped, there are clear limits to such extensions (e.g. the Ghana border).

6.31 Bobo-Dioulasso. ESMAP/MET estimated total fuelwood consumption in 1989 at 100,000 tons. Based on current per capita rates of fuelwood consumption (0.654 kg/per person/per day), Table 6.7 projects fuelwood demand for Bobo-Dioulasso through the year 2000. Using current population growth estimates, fuelwood consumption is expected to double to 212,000; using a lower estimate, fuelwood consumption would increase by about 126%.

6.32 Estimated annual productivity of priority areas within the Bobo-Dioulasso fuelwood supply zone is approximately 130,000 tons. Supplying fuelwood to the urban population through the year 2000 is not as critical a situation as is found in the other cities because of higher rainfall,

lower population densities and a generally larger area of accessible natural forests. At the same time, however, internal migration patterns are increasingly shifting towards the southwestern part of the country, making population projections and fuelwood demand estimates problematic.

6.33 One constraint to accessing wood resources in forests at distances ranging from 35-60 km from Bobo-Dioulasso is the poor condition of the road network. Unless they are improved, wood will continue to come from the most accessible sites, at least for the foreseeable future placing most of the pressure for fuelwood on old fallow and degraded woodlands closest to the city limits. Total production in year 15 from projects implemented on the five priority zones in the supply zone would yield about 121,000 tons of fuelwood.

6.34 Ouahigouya. Ouahigouya is the smaller of the four major cities with a 1990 population estimated at 47,700. Fuelwood and charcoal consumption is estimated to be about 13,800 tons per annum. Per capita consumption is the highest of the four cities at 0.895 kg/day due to the large amount of self-collection, low fuelwood prices and the poor access to alternative fuels. As shown in Table 6.8, projected demand to the year 2000 is estimated to grow by a little more than 50% to about 24,000 tons. Because there are no national forests within the supply zone, transport distance and road conditions are the key factors used to identify priority management zones. However, management of any or all of the areas will only become viable if the low producer price is increased to more accurately reflect the real costs associated with fuelwood production.

6.35 The annual production potential of the priority areas within the Ouahigouya fuelwood supply zone is about 38,000 tons and indicates that, with the introduction of forestry management, there is enough fuelwood to satisfy the city's demand through the year 2000. Using three different population growth rates, Table 6.8 illustrates fuelwood use scenarios if actual growth slows are grows more rapidly. The importance of reliable estimates of the base population and the annual growth estimates are once again underscored by these figures. From the year 1990 to 2000, fuelwood demand grows by 93% under the low growth scenario, but if the high estimates are used, demand jumps by more than 171% in the ten-year period.

6.36 Introducing natural forest management. Any strategy for the introduction of large-scale forestry management in Burkina Faso is necessarily a long term proposition. Both the agro-ecological and socio-economic complexities by region and by ethnic affiliation defy easy remedies. What is, nonetheless, clear is that the full participation of the rural population is a fundamental ingredient to any success in this domain. This means that rural communities must assume increasing responsibility and authority for the protection of forestry resources and that government ministries and agencies must facilitate this process. Expansion of the pilot operations under the ongoing Village Land Management Program into a national strategy is critical. The first step in furthering introduction of an urban household energy strategy will be a pilot phase in which forestry management operations, on a relatively modest scale, are launched and carefully monitored. The FAO-assisted pilot project at Nazinon is an example.

6.37 While the classification system gives priority to N, F, and M cover types, there is evidence to suggest that an important opportunity exists to manage the fuelwood resources on old fallow and degraded lands found within short distances (less than 50 km) of all the urban centers. Fuelwood coming from these areas already contributes substantially to overall supply. While little is known about the growth, biomass production, and management of these degraded areas, their

proximity to to the city centers provides an economic incentive for managing any wood product surpluses. Furthermore, the growth of this market could be expected to encourage villages to manage their land resources for the long term.

6.38 Local participation will be the keystone of the village forestry management plan. The management plan would have two main objectives: (a) sustained yield management of the forested area to ensure a continuous supply of fuelwood and (b) multiple use management to ensure that the management zone continues to provide a wide range of products while protecting the soil, providing wildlife habitat, and preserving biodiversity. A ten thousand hectare block of contiguous natural forest and woodlands would be identified and a woodlands management cooperative consisting of members from an adjacent village (or villages) would be organized for management in the designated area under the authority of the Forest Service.

6.39 A basic agreement between the cooperative and the Government would be established for each cooperative setting out the rights and responsibilities of the contracting parties. The management plan for the forestry zone in question would constitute the working guidelines for management which would be prepared by the Forest Service in close collaboration with the local cooperative (see Annex XI for indicative elements of a management plan). The management plan would, in particular, identify the specific compartment (s) of the zone that would be harvested each year as well as compartments or portions thereof that might require more intensive efforts to protect vital regeneration. Monitoring arrangements would be identified and agreed upon with the cooperative and Forest Service to assess performance.

6.40 When adjacent forest areas are put under management, random fuelwood collection will have to be discouraged. However, the local demand for self-collected wood can continue to be satisfied through two sources: (a) because of market preferences for specific dimensions and species, significant amounts of wood are generated during harvesting that will not be marketed in the urban centers and are left in the forest; and (b) forested zones within the fuelwood collection radius around a village that will not be brought under management. At the same time, the local population's access to the forest for hunting, grazing, medicines, plants, etc. must continue to be respected to prevent disruption of rural lifestyles.

The Economics of Natural Forest Management

6.41 The economics of forest management depend, on the one hand, on the increase in productivity above the natural rate of regeneration that is achieved by the introduction of management methods and, on the other hand, on the decrease in the natural rate of regeneration that could occur, if a forest area is cut and left to itself without protection. These two rates are unknown as obviously, they depend on individual circumstances. If it is assumed that natural forest management increases productivity by 20% above the natural rate of regrowth, and that indiscriminate cutting down of forest cover decreases it by 20%, then it can be shown that the increase in production over a 30 year period by forest management along the lines produced in this report (15 year rotation period; only half of each plot cut per year during the first 15 years) will correspond to an IRR of about 5% (see Annex XII). This rate does not take into account an estimate of the additional benefits arising from the multiple uses of the forest by the local populations, those of increased environmental protection and conservation, nor, on the other hand, the manpower costs of forest management.

Table 6.3: Main Cover Type Classification Used with the Urban Fuelwood Supply Zone Maps

Classification	Explanation
N	Natural forest without evidence of agricultural fields (small, isolated fields < 1.5 ha may go undetected). These lands are assumed to contain 100% of the standing volume estimated by other sources.
F	Low density agriculture with at least 50 percent of the land in natural forest or old fallows; or, less than 50 percent of the map unit is covered by fields and recent fallows. Only 66% of the standing volume estimated for natural forests is assumed to exist on these lands.
M	Natural forest and old fallows cover 10 to 50 percent of the land; medium density agriculture predominates, 50 to 90 percent of the map unit is covered by fields or recent fallows. Only 33% of the standing volume estimates for natural forests is assumed to exist for these lands.
O	Less than 10 percent in natural forests, 0% to 90 percent in fields, recent fallows, and degraded forest lands.
J	Agriculture land with over 50 percent in older fallow or degraded forest land. Only 25% of the standing volume estimates for natural forests are assumed to be applicable for this class. (Class doesn't exist on the Ouahigouya map.)
C, J-C	Degraded forest and/or old fallows over ironstone that have a low potential for agriculture. Less than 50 percent of area is under cultivation. Only 25% of the standing volume estimates for natural forests are assumed to be applicable to this class.
P	Industrial-scale forest plantations. Plantations are assumed to contain standing volumes equivalent to 100% of the estimates for natural forests.
N, Co	Natural forests on very steep hills that could be an impediment to natural forest management. (Only on the Bobo-Dioulasso map).
I	Seasonally flooded stream deltas, vegetation type unknown. (Occurs only on the Ouahigouya map.)

Adapted from Grosenick and Hagen (1988b)

Table 6.4: Estimated Annual Productivity of Natural Forests of Selected Priority Areas of Fuelwood Supply Zones

Urban Area	Class N			Class F			Class M			Total tons
	Ha*	M3+	Tons#	Ha*	M3+	Tons#	Ha*	M3+	Tons#	
Ouagadougou	394400	257489	205991	310100	200602	160482	110000	72414	57931	424404
Koudougou	26500	17596	14077	10600	7038	5630	34000	20889	16711	36418
Bobo-Dioulasso	35100	38189	30551	76900	83667	66934	5000	41344	33075	130560
Ouahigouya	20500	7296	5837	45700	11699	9359	110100	28186	22549	37745
Totals	484500	320570	256456	443300	303006	242405	259100	162033	130266	629127

* Area estimates from forest cover maps
\+ Volumes calculated using average growth estimates from Clement (1982)
\# Assumes: 0.8 tons/m^3 (DeBaker 1982)

Additional assumptions:

- 80% of the growth is in commercial fuelwood species (Grosenick et Hagen 1988b)
- Priority areas were identified for natural forest management within each city's fuelwood supply zone using criteria discussed in Chapter 2. The figures provided in this table only reflect fuelwood growth in these selected areas. Rural fuelwood demand will be met from other sources.

Table 6.5: Population Projections and Household Woodfuel Demand Estimates for Ouagadougou

	1985	1990			1995			2000		
Growth rate	Base	Low	Median	High	Low	Median	High	Low	Median	High
Population estimate	442837	615319	709312	729550	854981	1136136	1201895	1187990	1819800	1980059
Fuelwood demand										
Weight equivalent (tons)	118317	164401	189514	194921	228434	303553	321122	317407	486214	529032
Volume equivalent (m^3)	147896	205501	236892	243652	285542	379441	401403	396759	607768	661290

Assumptions:

Annual population growth rate

Low 6,80% Kadiogo Province (INSD, 1988)
Median 9,88% (Mostert, 1989)
High 10,50% "estimate"

Woodfuel consumption

Wood 0,622 kg/p/day (Mostert 1989)
Charcoal 0,022 kg/p/day (Mostert 1989)

SAMPLE CALCULATION: Estimated fuelwood demand (w. equivalent) in 1995 using the low population growth rate

Population estimated for 1995

(442.837) x (1,068)**10 = 854.,981

Fuelwood demand

Wood	[0,622 kg/pers./day x 854.981 persons]/1000 kg/ton	=	532 tons/day
Charcoal	[0,022 kg/pers./day x 5,.0 kg char/kg wood x 854.,981 pers.]/1000kg/ton	=	94 tons/day
	Total, wood/day	=	626 tons/day
	625,846 tons/day x 365 days/year — Total, wood/day	=	220.434 tons/year

Table 6.6: Population Projections and Household Woodfuel Estimates for Koudougou

	1985	1990			1995			2000		
Growth rate	Base	Low	Median	High	Low	Median	High	Low	Median	High
Population estimated	51556	55267	60996	65800	59246	72165	83979	63511	85378	107181
Fuelwood demand										
Weight equivalent (tons)	15261	16360	18056	19478	17538	21362	24859	18800	25273	31727
Volume equivalent (m^3)	19077	20450	22570	24347	21922	26702	31074	23500	31592	39659

Assumptions:

Annual population growth rate

Low 1,40% Boulkiemde Province (INSD, 1988)
Median 3,42% (Mostert, 1989)
High 5,00% "estimate"

Woodfuel consumption

Wood 0,641 kg/person/day (Mostert 1989)
Charcoal 0,034 kg/person/day (Mostert 1989)

SAMPLE CALCULATION: Estimated fuelwood demand (w. equivalent) in 1990 using the high population growth rate

Population estimated for 1990

(51.556) x (1,050)**5 = 65.800

Fuelwood demand

Wood	[0,641 kg/pers./day x 65.800 person]/1000 kg/tonne	=	42 tons/day
Charcoal	[0,034 kg/pers./day x 5,0 kg char/kg wood x 65.800 pers.]/1000kg/ton	=	11 tons/day
	Total, wood/day	=	53 tons/day

53,364 tons/day x 365 days/year Total, wood/year = 19.478 tons/year

Table 6.7: Population Projections and Household Woodfuel Demand Estimates for Bobo-Dioulasso

	1985	1990			1995			2000		
Growth rate	Base	Low	Median	High	Low	Median	High	Low	Median	High
Population estimate	231162	281244	326191	347588	342176	460286	522653	416310	649506	785891
Fuelwood demand										
Weight equivalent (tons)	75430	91773	106439	113422	111656	150196	170547	135846	211940	256444
Volume equivalent (m^3)	94288	114716	133049	141777	139569	187745	213184	169808	264925	320555

Assumptions:

Annual population growth rate

Low 4,00% Houet Province (INSD, 1988)
Median 7,13% (Mostert, 1989)
High 8.50% "estimate"

Woodfuel consumption

Wood 0,654 kg/p./day (Mostert 1989)
Charcoal 0,048 kg/p./day (Mostert 1989)

SAMPLE CALCULATION: Estimated fuelwood demand (w. equivalent) in 1995 using the median population growth rate

Population estimate for 1995

(231.162) x (1,0713)**10 = 420.286

Fuelwood demand

Wood	[0,654 kg/pers./day x 460.286 persons]/1000 kg/ton		=	301 tons/day
Charcoal	[0,048 kg/pers./day x 5,0 kg char/kg wood x 460.286 pers.]/1000kg/ton		=	110 tons/day
		Total, wood/day	=	411 tons/day
	411,495 tons/day x 365 days/year	Total, wood/year	=	150.196 tons/year

Table 6.8: Population Projections and Household Woodfuel Demand Estimates for Ouahigouya

	1985	1990			1995			2000		
Growth rate	Base	Low	Median	High	Low	Median	High	Low	Median	High
Population estimate	38795	40372	47679	49513	42013	58596	63193	43720	72014	80652
Fuelwood demand										
Weigh: equivalent (tons)	12673	13188	15575	16175	13725	19142	20644	14282	23525	26347
Volume equivalent (m^3)	15842	16486	19469	20218	17156	23927	25804	17853	29406	32934

Assumptions:

Annual population growth rate

Low	0,80% Yatenga Province (INSD, 1988)
Median	4,21% (Mostert, 1989)
High	5,00% "estimate"

Wood fiber consumption

Wood	0,81 kg/person/day (Mostert 1989)
Charcoal	0,017 kg/person/day (Mostert 1989)

SAMPLE CALCULATION: estimated fuelwood demand in the year 2000 using the low population growth rate

Population estimate for the year 2000

(38.795) x (1,008)**15 = 43.720

Fuelwood demand

Wood	[0,810 kg/pers./day x 43.720 persons]/1000 kg/ton		=	35 tons/day
Charcoal	[0,017 kg/pers./day x 5,0 kg char/kg wood x 43.720 pers.]/1000kg/ton	4 tons/day		
		Total, wood/day	=	39 tons/day
	39,130 tons/day x 365 days/year	Total, wood/year	=	14.202 tons/year
	[14.282 tons/year]/0,8 tons/m^3	or	=	17.853 m^3/year

VII. AN URBAN HOUSEHOLD ENERGY STRATEGY: REINFORCING GOVERNMENT POLICY

A. Introduction

7.1 The previous chapters reviewed government policy and performance in household energy and set out the context for medium and longer term household energy planning and policy definition. These sections concluded that policy options to manage the energy transition are constrained by social, natural resource, geographical and foreign exchange conditions. Against this background, Chapter VII proposes an urban household energy strategy and makes recommendations on follow-up activities for implementation.

7.2 The preceding analysis underscored the limited number of policy options available to Government. Reducing fuelwood demand through increasing taxes would have only a modest impact in the absence of massive fuel switching. The prospects for substitution are limited because: (a) the landed cost of LPG and kerosene is twice as high as the foreign ex-refinery price, undermining the price competitiveness of the petroleum fuels; and (b) given the country's small export base, foreign exchange considerations require that government keep fuel imports as low as possible. The urban poor already spend as much as 25% of household income on energy and would face considerable hardship in purchasing an LPG or a kerosene stove.

7.3 A fully successful improved fuelwood stove program can reduce fuelwood consumption by about 20-30%. The national improved stove program has not achieved these savings. Increasing fuelwood supply through commercial reforestation schemes is not financially viable. Because of the rather low annual productivity of the forests -about 0.8 m3 per hectare-the cost of fuelwood production exceeds realistic price expectations. On-going village-lot woodfuel schemes have had organizational and implementation difficulties and, in any case, do not provide a realistic source of fuelwood for the urban market; in light of population trends, any future surpluses would be absorbed in the rural context.

7.4 Government's household energy policy, promoting energy savings, switching to alternative fuels, and rationalizing the fuelwood supply network, has had the necessary components to mitigate the impact of these obstacles if not eliminate them. However, the mix of components and institutional arrangements has not been adequate to meet the program's objectives, especially in light of the rapidly increasing urban population and the projected impact of this growth on the natural resource base. The high level of direct Government involvement that produced results at the outset of the improved stove program has been inadequate to sustain the program over the longer term. It has also failed to mobilize sufficient households to contain the depletion of the country's natural resource base. On the supply side, fuelwood management operations are few in number and at a very early stage of implementation. Inter-fuel substitution activities have been hampered by the high cost of moderns fuels, the inadequacy of stove equipment, problems in distribution and the widespread skepticism about their safety and convenience.

A Revitalized Government Strategy

7.5 The strategy presented in this chapter addresses the accelerating demand for household energy in the urban areas and proposes a series of measures to bring this demand in line with long term sustainable supply. It aims to address the bottlenecks identified in on-going improved stove programs and recommends the changes required to accommodate the increasing demand for household energy in Burkina's four major cities. Whereas past Government efforts have emphasized demand management through improved stove dissemination, the strategy set out in this

report recognizes the need to strengthen this effort but also the importance of managing the country's forest resources and proposes, as a consequence, a shift in emphasis. The major share of the increase in fuelwood demand between now and the year 2000 will have to be met from the existing tree stocks. Current unsustainable fuelwood harvesting practices will need to cease and rural populations provided with the right incentive environment to assure the management of these resources over the longer term. Nonetheless, even with forestry management plans, LPG and kerosene will have to meet the household energy requirements of the total increment in urban growth beginning in the early years of the next century. Therefore, efforts must be undertaken now to effectively plan for and manage the transition to modern fuels, which is well underway in the urban centers.

7.6 Objectives. The immediate objectives of a revitalized program would be to (a) slow the urban household and informal sector demand for woodfuels by promoting fuelwood savings and fuel switching where technically, financially and socially feasible; and (b) increase the productivity of the natural woodlands through the introduction of forestry management plans. This program would aim to reach the following targets for the year 2000:

(a) 80% or 220,000 urban households to use improved biomass stoves to cover most of their cooking needs;

(b) 100% of the informal sector beer brewers to use the Burkido stove;

(c) 41% or 115,000 urban households to use LPG and kerosene stoves to cover their auxillary cooking needs; and

(d) at least 50% of commercial fuelwood to be produced by woodland management cooperatives.

7.7 To reach these objectives, Government must fine-tune present policies--changing their emphasis and expanding their scope. This fine-tuning will entail: (a) a shift from a rural energy savings program to one that is concentrated on measures to restrain the urban demand for fuelwood; (b) an increased reliance on private-sector based initiatives (c) a more comprehensive use of pricing policy as an instrument to achieve program objectives; and (d) capacity building measures.

7.8 Shifting to an urban-based strategy. While Burkina Faso is predominantly rural and will remain so over the longer term, it is the rapidly growing urban sector that poses a far more serious problem for the management of forestry resources. Because the rural population tends to meet its fuelwood requirements from dead wood, the impact on the environment is less important than that due to clearfelling for agricultural development. In contrast, between now and the year 2000, the intensive and concentrated urban fuelwood demand will contribute directly to environmental degradation, since a rising share of this natural resource is mined exclusively for the urban market. Because these mined areas are not used for agricultural purposes and are unprotected from wind and rain, soil degradation is most severe and the regenerative capacity of the tree cover is lost. Action to restrain urban demand must, therefore, receive clear priority and need to be directed, in the short term, to Ouagadougou on the central plateau, where the majority of urban residents live.

7.9 Government will need to continue to promote energy savings programs for the rural population. It will, nonetheless, be necessary that these efforts be reformulated and resources more efficiently deployed than has been the case in the past. For example, the development of a rural energy campaign built around energy savings measures in traditional cooking practices could be

more cost-efficient than the current emphasis on the dissemination of rural stoves, which has met with limited success. Under any circumstances, an evaluation of rural efforts will be a sine qua non to the definition of a new rural program.

7.10 Relying on the private sector. Notwithstanding the important strides made by Government in introducing improved stoves and in underscoring the importance of energy-saving behavior, the national improved stove program is stagnating. Around 35% of urban households use the improved stove for about 60% of their cooking and heating tasks. Present sales are not enough to keep pace with the growing population nor to meet replacement needs of worn out stoves. Furthermore, in the absence of sufficient demand and in response to Government intervention throughout the production-marketing chain, the informal sector has largely abandoned stove production. To ensure that the long term objectives of the strategy are reached, it is essential to re-orient Government's role and increase the participation of the private sector. Relying more on NGOs active in stove dissemination and forestry management activities is one way to encourage this shift to the private sector. Promoting autonomous stove production and distribution networks is another. On the supply side, the increased reliance on the rural population to manage forestry resources is a relatively recent initiative and will require close monitoring to ensure an optimal institutional framework.

7.11 Using pricing policy more aggressively. Government has a policy of administered prices for fuels. This policy has three main features: (a) the price is set for each actor in the production-consumption chain; (b) subsidies are avoided and (c) the price stabilization fund is used to even out the fluctuations in the price of imported oil products. As this report has shown, Government has been largely successful in ensuring that energy consumers are provided with correct relative economic prices. Government policy has been less successful, however, in providing the suppliers with the correct signals. Actions need to be taken to correct these anomalies.

7.12 In addition, the role of the price stabilization fund needs to be reviewed. Its role should be to protect the consumer against short-term price volatilities, while allowing for long-term changes in prices. There is a risk that the existence of the fund postpones changes in the consumer price beyond what is reasonable from the short-term price stabilization objectives. To avoid this, Government policy should be to revise the import price element in the price structure on an annual basis in accordance with international price expectations.

7.13 Strengthening institutional capacity. This report has highlighted the institutional fragmentation in the energy sector. The array of sectoral ministries and state agencies involved in woodfuel and petroleum product consumption and in forestry management tend to operate with a minimum of coordination. This situation has particularly serious consequences for the availability of adequate fuelwood to meet urban household energy requirements. For example, and with few exceptions, the opening of land areas for agricultural development has largely occurred without due consideration for recovering the felled wood for energy. At current urban growth rates, this situation cannot be allowed to continue. Similarly, research and development of LPG and kerosene stove equipment has been conducted without adequate consultation with the oil companies who will be called upon to market these products.

7.14 The institutional framework that provides the umbrella for household energy activities is largely the same one that will be called upon to implement the National Environmental Action Plan currently under preparation. The issue of institutional coordination, as it affects all agencies involved in the conservation of natural resources, has been raised in the context of the on-going preparation of the National Environment Action Plan. Because activities in household energy are closely linked with those of other institutions that aim to preserve and protect Burkina's natural

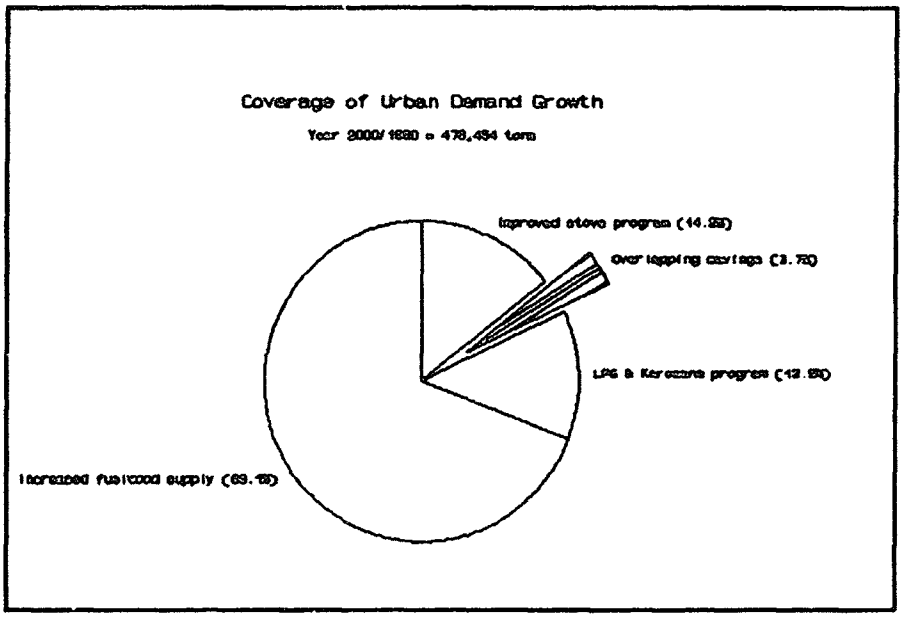
resource base, questions of institutional strengthening and training should be addressed as an integral part of the Plan and not as a separate exercise. The strategy proposed in this report will, nonetheless, address a limited set of capacity building issues that are deemed essential to the fine-tuning process. It is recommended that the Inter-Ministerial Committee concerned with the National Environmental Action Plan consider the overall issue of institutional strengthening to define and implement suitable household energy strategies and investment packages over the longer term.

7.15 Strategy Elements. To implement the urban household energy strategy, a series of short-term measures and longer term investments are recommended for follow-up action. These measures and investments should be implemented as a complement to on-going household energy activities and should be fully integrated into the National Environment Action Plan (NEAP). The short-term measures, at little or zero cost, would begin to re-orient present policies and establish a framework that would lead to the desired results. The longer-term investments involve pilot activities, training, and project proposals in fuelwood demand and supply management. The follow-up investments are set out in Table 7.1. below and described in more detail in Annex XIII. Financing has not been identified for these activities.

Project Title	Total Estimated Cost in US$	Implementation Period	Funding Source
Fuel Conservation Program			
Urban Fuelwood Savings Project	1,500,000	2 years	To be identified
Institutions and Training Needs Assessment	100,000	12 months	To be identified
Inter-Fuel Substitution Program			
LPG Infrastructure Strengthening Project	700,000	12 months	To be identified
LPG Stove Development and Marketing Project	100,000	10 months	To be identified
Kerosene Promotion Options	40,000	6 weeks	To be identified
Natural Woodlands Management			
Improving inter-Agency Coordination Workshop	45,000	6 weeks	To be identified
Village-based Management of Old Fallows and Degraded Woodlands Project	5,000,000	5 years	To be identified

7.16 Implementation of the urban household energy program will generate total energy savings in the year 2000 of approximately 145,000 tons of fuelwood, or about 80,000 tons resulting from an improved stove program aimed at the household and informal sectors; and about 65,000 tons from an LPG and kerosene program as shown in Figure 7.1 and in Annex XIV. Implementation of the improved stove program based on the objectives in paragraph 7.7 above would have an NPV of 2.6 billion CFAF (US$ 8.7 million) and an IRR of 570% (see Annex XV).

Figure 7.1: Coverage of Urban Demand Growth: 1990-2000
(477,000 tons)



7.17 The proposal for natural woodlands management, which would assess the feasibility of restoring old fallows and degraded woodlands for urban fuelwood supply, amongst other uses, is put forth as a complement to on-going forestry management efforts. These activities are primarily concentrated in Burkina's national forest and **domaine protégé** lands. Given the volume of fuelwood entering the cities from the degraded areas together with their good access to the city, it has been concluded that this largely untested option could have potential for generating vitally needed woodfuel resources as well as increased benefits from restored forest areas. Implementation of this experiment in natural forestry management yields an IRR of 5%, which reflects the benefits arising from the increase in forest productivity only. Those benefits due to the multiple uses of the forest by the local population, those of increased environmental protection and conservation, nor the manpower costs of natural forest management.

7.18 The strategy and investment program set out in this report are consistent with the energy and environmental recommendations of the Long Term Perspectives Study for Africa (LTPS). The LTPS highlights the need to address the household energy demand of the majority of the population of Sub-Saharan Africa that currently uses fuelwood and can be expected to do so over the longer term. It emphasizes the need both to broaden the use of improved fuelwood stoves as well as to encourage the shift to substitute fuels. The LTPS underscores the importance of identifying and testing different forestry management alternatives to protect the ecological base and to create an enabling environment that will encourage the broad-based popular participation needed to reach this objective.

B. Urban Woodfuel Conservation Program

7.19 A re-oriented urban woodfuel conservation program would: (a) better capture household consumer desires and requirements for improved woodstove equipment through expanded market surveys; (b) design market campaigns tailored to the regional characteristics of the four main cities and anchored in modern advertising techniques; (c) give increased priority to energy savings campaigns that target traditional cooking practices; (d) intensify fuelwood savings activities within the informal urban sector and, in particular, the traditional beer brewers; and (e) develop implementation arrangements with the private sector to carry out these programs.

7.20 The MET would assume a different set of functions within an urban-based woodfuel conservation program that is anchored in a market approach. It would be responsible for the definition of policy objectives; raising local, multilateral and bilateral financing for product development and for energy saving campaigns; issuing of annual calls for tenders 63/ to organize and implement urban improved stove dissemination and energy saving campaigns; organizing seminars to exchange views and information transfer international and national experiences and for program monitoring on a quarterly or semi-annual basis. Implementation of both the energy saving campaigns and the dissemination of improved stoves would be the responsibility of local NGOs.

7.21 A successful improved stove program for the urban sector could be expected to reduce fuelwood consumption in the urban sector from the trend-based 770,000 tons to 705,000 tons, assuming that the improved stoves will be used for 60% of the cooking tasks. Efforts to ensure that the improved stove is maintained and used correctly could result in even higher savings. At the same time, a 100% penetration of the **Burkido** stove could reduce informal sector fuelwood consumption from the trend-based 115,000 tons to 95,000 tons. Thus, total savings from a revised and reoriented improved stove strategy would reduce total consumption by about 84,000 tons in the year 2000. Total additional fuelwood savings over the 1990-2000 period would amount to 234,00 tons.

Short-term Measures

7.22 The MET should:

(a) develop links with NGOs for stove dissemination activities;

(b) replace ad-hoc campaigns with regular year round promotions;

(c) abandon promotional pricing during campaigns;

(d) make use of modern marketing techniques for stove dissemination campaigns;

(e) widen consumer choice e.g. marketing of multi-pot stoves;

(f) discontinue public sector sales outlets;

63/ *The tenders would be published by the MET, and would, inter alia, define the available budget, the broad goals of the campaigns, and possibly some guidelines/requirements - e.g. to introduce door-to-door sales in several quarters of the city.*

(g) abandon the policy of setting producers' and retailers' margins; and

(h) improve coordination with IBE to jointly identify priority research and seek funding.

7.23 Two follow-up activities have been identified:

(a) Urban Fuelwood Savings Project and

(b) Institutions and Training Needs Assessment

C. Inter-fuel Substitution Program

7.24 The transition from biomass to modern fuels is an on-going process. Government efforts to date have largely emphasized LPG promotion, but need to be broadened to include kerosene. Kerosene is easier to use and more affordable for the majority of the urban population that could be expected to switch from biomass to alternative fuels. Because an increase in the urban demand for fuelwood in the early years of the next century can only be met with reductions in the resource base, management of the transition from biomass to modern fuels must now be the subject of systematic planning. This process should occur in two phases: (a) removing the cultural, psychological and price barriers to LPG and kerosene penetration and (b) promoting the wide-scale use of substitute fuels. It is the first phase that is addressed in this strategy document.

7.25 **Pricing policy** will be a key instrument to promote the fuel transition. Based on the price structure set out Chapter IV, **it is proposed** to:

(a) eliminate taxes on LPG marketed in 3 kg and 6 kg bottles and on kerosene destined for domestic consumption. This measure should result in a price of "popular" LPG of 272 CFAF/kg (down from 330 CFAF) and of "domestic" kerosene sold directly from pumps at the gasoline stations of 113 CFAF/liter (down from 160 CFAF). LPG marketed in 12 kg bottles (and above) should continue to be taxed, although some downward adjustment of the price may be necessary to avoid a more widespread switch of 12 kg bottle owners to 3 and 6 kg bottles (and thus underutilization of the existing 12 kg bottle park);

(b) lower transport rates to a level that still ensures an adequate rate of return to the transporters;

(c) increase SONABHY's margins to allow full cost recovery for the bottling plant including amortization of plant, labor, operating and energy costs, as well as maintenance and renewal of LPG bottles (30,000 CFAF/ton); to account for 4% spillage in loading, transport and filling; and to provide a 15% operators' margin on the sales price;

(d) eliminate the provision for security storage and for promotion campaigns;

(e) triple the provision for the transport of bottles from Bingo to Ouagadougou to take account of the weight of bottles ex-LPG in the transport to and from Ouagadougou. The margins for the distributors have been set at 15%, which is the normal commercial

margin in the region, 9% for the wholesaler (to cover the cost of storage, financial costs, financing of the working stock of cylinders and client risk) and 6% for the retailer;

(f) Set the margins in the kerosene price structure to reflect the specific services the oil companies intend to provide to the informal retailers. If a distribution system with specialized small trucks is set up, the wholesale margin for those sales should be increased to incorporate at least the defined margin for retailing at the gasoline station; and

(g) add a dye to the detaxed kerosene and carry out periodic inspections of industrial equipment and of diesel-powered cars to discourage the use of de-taxed kerosene for purposes other than domestic lighting and cooking.

7.26 This new structure should promote fuelwood substitution by: improving the relative price competitiveness of the substitute fuels; ensuring the financial viability of SONABHY's bottling operations (and thus the accumulation of financial reserves for future investments in maintenance and in capacity expansion); and providing incentives to wholesalers to expand the retail network served by them.

7.27 It is, furthermore, proposed that the psychological and cultural barriers to a more widespread use of substitute fuels be addressed through LPG promotion campaigns and through accelerating the on-going research and development of appropriate kerosene equipment. This objective would be reached through (a) the design and implementation of promotion campaigns anchored in a comprehensive market analysis of existing and potential LPG consumers; (b) the acceleration of research and test marketing of kerosene stoves; and (c) strengthening the infrastructure network for LPG distribution.

Short-term Measures

7.28 SONABHY should:

(a) assist in developing LPG and kerosene promotion campaigns that effectively feature their attractions and;

(b) stimulate collaboration between IBE and the private oil companies to design and promote a suitable kerosene stove.

7.29 Three follow-up activities are identified below:

(a) LPG Infrastructure Strengthening Project;

(b) LPG Stove Development and Marketing Project;

(c) Kerosene Promotion Options Project.

D. Natural Woodlands Management

7.30 Implementation of successful demand-side interventions could reduce the projected fuelwood consumption (900,000 tons) by 140,000 tons in the year 2000. Nonetheless, the forestry

sector must still increase the supply of fuelwood to the urban areas by more than 313,000 tons of fuelwood to accommodate a tripling of the demand between 1989-2000. Reaching this objective will require a strong Government commitment to natural forest management. Policy initiatives must aim to accelerate and strengthen the introduction and use of village-level forestry management practices to secure this supply. This process is already underway on a very limited scale in a FAO-assisted project in the national forest of Nazinon within the Ouagadougou supply zone. There are, in addition, projects under preparation to introduce forestry management on the **domaine protege** lands. The feasibility of managing forest resources on old fallows and degraded woodlands within a 50 km radius of the major urban centers also needs to be assessed.

7.31 Given this critical role of forestry management, supply-side interventions will receive more emphasis in the future than they have in the past. In particular, the move to organize woodlands management cooperatives must be accelerated and the experience gained in the first experiments must be closely monitored and the results widely disseminated. Land and tree tenure issues that are key to the mass mobilization of the rural population must be addressed as priority and steps taken immediately to identify and put in place mechanisms that will provide sufficient incentives to the participating populations to begin the task of preserving their natural environment. The considerable strides made in recovering woodfuel product revenues must be reinforced by measures to increase this recovery and contribute to the forestry management program. Critically important for the success of this program will be a commitment to experiment and evaluation.

7.32 Pricing policy will be a critical tool in the move towards sustainable forestry management and the Government can take several important steps in this direction, **over the medium term**. First, it can reduce the transporters' margins by introducing more competition in the fuelwood transport sector i.e., by allowing partial loads or return loads on non-authorized vehicles. Second, Government should consider: (a) introduction of a system of **differentiated cutting permit fees** for the three sources of supply - managed, unmanaged, and land clearing; the lower rate should apply to "managed" fuelwood and be equivalent to the forestry service's cost of assistance; the higher rate should apply to "unmanaged" fuelwood and be equivalent to the full stumpage value of fuelwood (that is, the cost of production of managed supplies including the cost of the forestry service assistance) and (b) the designation by the MET, in consultation with agricultural authorities, of zones within the expansion of the agricultural frontier as special supply zones; the system of differentiated cutting permit fees would be applied to these zones.

7.33 Institutional coordination and capacity building is fundamental to all of the strategy components, but especially critical in the case of natural woodlands management. This component of the strategy will place particular emphasis on identifying the bottlenecks to strengthening institutional capacity and improving inter-agency coordination. Fundamental to this process will be the development of links between the Ministries of Agriculture and of the Environment and Tourism to identify mechanisms to make wood available from agricultural land clearing activities for household energy purposes.

Short-term Measures

7.34 The MET should:

(a) create an Urban Fuelwood Working Group within the ministry to oversee urban fuelwood supply and marketing activities and the evolution of natural forest management activities. Amongst the issues it could consider include: methods to improve recovery of fuelwood revenues; an incentive system to recover wood for energy

from land clearing for agricultural development; need for a differential tax structure from unmanaged lands;

(b) liaise with the Ministry of Rural Cooperatives and the Village Land Management Program in establishing and operating forestry management cooperatives;

(c) opt for a phased program of village-based forestry management by establishing one pilot cooperative in each of the urban fuelwood supply zones;

(d) move to reconcile or correct the lack of fuelwood transport fees in the Bobo-Dioulasso supply zone;

(e) review the present fuelwood demand/supply and price situation and, in particular, the low producer price, in Ouahigouya and its negative impact on the promotion of forestry management schemes; and

(f) publish price guidelines (price structures) for the consumer to put some downward pressure on attempts at price gouging.

7.35 Two follow-up activities have been identified below.

(a) Improving Inter-Agency Coordination Workshop; and

(b) Village-based Management of Old Fallows and Degraded Woodlands Pilot Project.

FUELWOOD DEMAND FORECASTS

Figure A1.1: Fuelwood Demand/Supply Balance

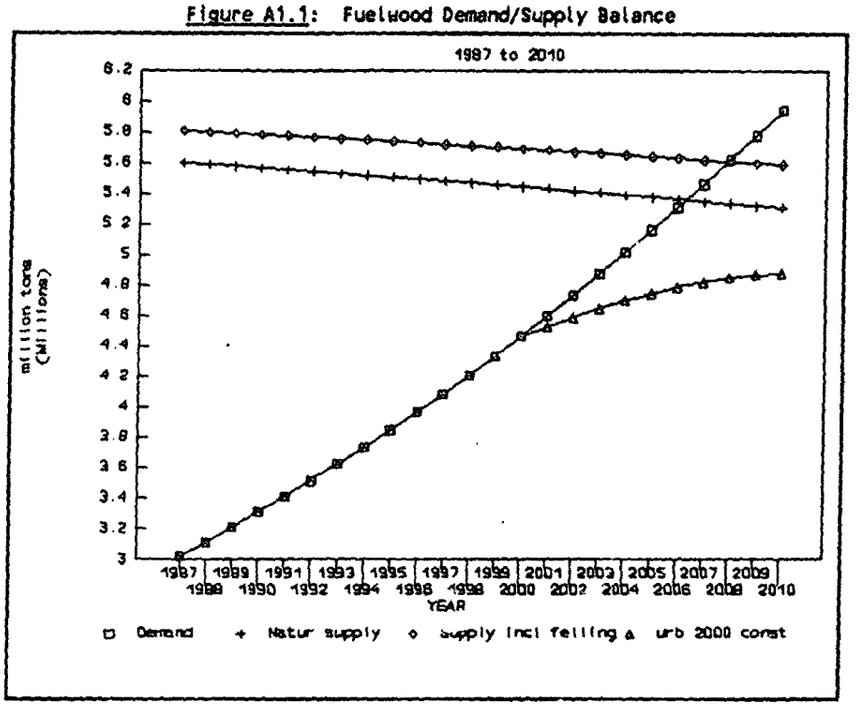
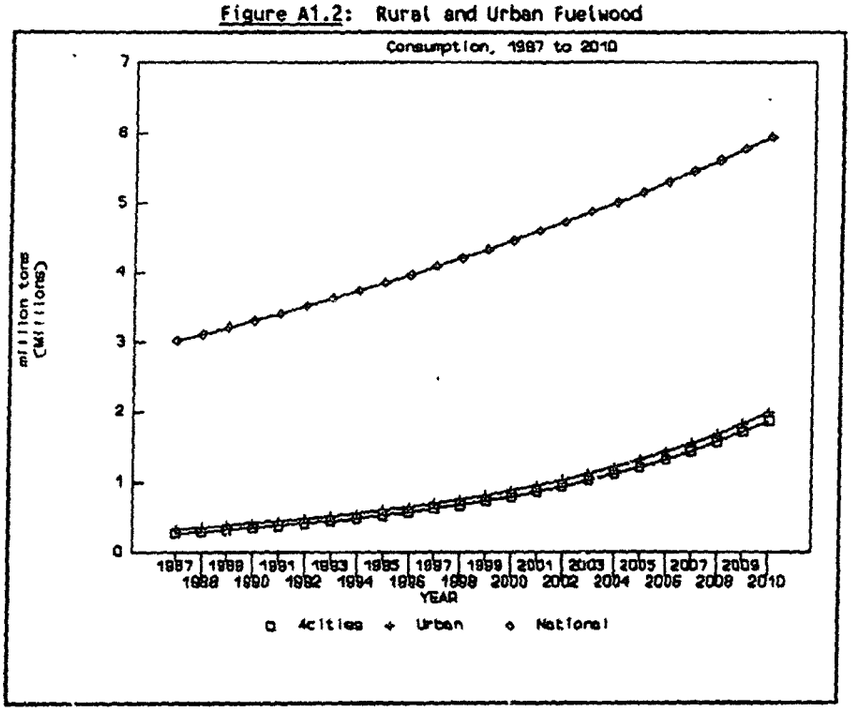


Figure A1.2: Rural and Urban Fuelwood



Forecast of Urban Household Energy Consumption in Burkina Faso
Hypothesis: Prolongation of Present Trends with Regard to Population Growth and Consumption Levels
Population Projection

	Population Growth	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Ouagadougou	0,0988	443000	486768	534861	587705	645771	709573	779679	856711	941354	1034360	1136554	1248846	1372232
Bobo-Dioulasso	0,0713	231000	247470	265115	284018	304268	325962	349204	374102	400775	429350	459963	492759	527892
Koudougou	0,0342	52000	53778	55618	57520	59487	61521	63625	65801	68052	70379	72786	75275	77850
Ouahigouya	0,0421	39000	40642	42358	44136	45994	47930	49948	52051	54243	56526	58906	61386	63970
TOTAL 4 CITIES		765000	828659	897947	973379	1055520	1144987	1242458	1348665	1464423	1590615	1728210	1878266	2041944
Other cities	0,032	139000	143448	148038	152776	157664	162710	167916	173290	178835	184558	190464	196558	202848
Rural Population	resid.	6966000	7180693	7367705	7556773	7747597	7939830	8133075	8326883	8520742	8714075	8906231	9096477	9283990
TOTAL	0,032	7900000	8152800	8413690	8682928	8960781	9247526	9543447	9848838	10164000	10489248	10824904	11171301	11528783

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ouagadougou	1507808	1656780	1820470	2000332	2197965	2415124	2653738	2915928	3204021	3520579	3868412	4250611	4670571
Bobo-Dioulasso	585531	605853	649051	695328	744905	798016	854915	915871	981172	1051130	1126075	1206364	1292378
Koudougou	80512	83266	86114	89059	92104	95254	98512	101881	105366	108969	112696	116550	120536
Ouahigouya	66663	69470	72394	75442	78618	81928	85377	88972	92718	96621	100689	104928	109345
TOTAL 4 CITIES	2220515	2415369	2628028	2860161	3113593	3390323	3692543	4022651	4383276	4777298	5207871	5678453	6192830
Other Cities	209339	216038	222951	230086	237449	245047	252888	260981	269332	277951	286845	296024	305497
Rural Population	9467850	9647023	9820360	9986576	10144240	10291760	10427367	10549096	10654767	10741962	10808006	10849932	10864463
TOTAL	11897704	12278431	12671340	13076823	13495282	13927131	14372799	14832728	15307376	15797212	16302722	16824409	17362791

Annual Fuel Consumption by Households in Tons, Informal Sector Consumption of Fuelwood is Calculated by adding 18% to Household Fuelwood Consumption

OUAGADOUGOU	Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1988
Fuelwood	0,622Kg/per/day	121430	133427	146609	101094	177010	194499	213716	234831	258032	283526	311538	342318
(addit. consumption of informal sector)		21857	24017	26390	28997	31862	35010	38469	42270	46446	51035	56077	61617
Charcoal	0,022Kg/per/day	4295	4719	5186	5698	6261	6879	7559	8306	9127	10028	11019	12108
LPG	0,950Kg/per/day	508	558	613	674	741	814	894	983	1080	1186	1304	1432
Kerosene	0,210Kg/per/day	112	123	136	149	164	180	198	217	239	262	288	317
BOBO-DIOULASSO	**Year**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1988**
Fuelwood	0,654Kg/per/day	63286	67798	72632	77810	83358	89302	95669	102490	109798	117626	126013	134998
(addit. consumption of informal sector)		11391	12204	13074	14006	15005	16074	17220	18448	19764	21173	22682	24300
Charcoal	0,048Kg/per/day	4645	4976	5331	5711	6118	6554	7022	7522	8059	8633	9249	9908
LPG	0,376Kg/per/day	100	107	114	123	131	141	151	161	173	185	198	213
Kerosene	0.210Kg/per/day	56	60	64	68	73	79	84	90	97	103	111	119
KOUDOUGOU	**Year**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1988**
Fuelwood	0,641Kg/per/day	13013	13458	13918	14394	14886	15395	15922	16466	17029	17612	18214	18837
(addit. consumption of informal sector)		2342	2422	2505	2591	2680	2771	2866	2964	3065	3170	3279	3391
Charcoal	0,034Kg/per/day	690	714	738	763	790	817	845	873	903	934	966	999
LPG	0,336Kg/per/day	19	19	20	21	21	22	23	24	24	25	26	27
Kerosene	0,210Kg/per/day	12	12	12	13	13	14	14	15	15	16	16	17
OUAHIGOUYA	**Year**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1988**
Fuelwood	0,810Kg/per/day	12522	13049	13598	14171	14767	15389	16037	16712	17416	18149	18913	19709
(addit. consumption of informal sector)		2254	2349	2448	2551	2658	2770	2887	3008	3135	3267	3404	3548
Charcoal	0,017Kg/per/day	263	274	285	297	310	323	337	351	366	381	397	414
LPG	0,000Kg/per/day	0	0	0	0	0	0	0	0	0	0	0	0
Kerosene	0,210Kg/per/day	9	9	10	10	10	11	11	12	12	13	13	14
TOTAL 4 CITIES	**Year**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1988**
Charcoal		9893	10683	11540	12470	13478	14573	15762	17052	18454	19976	21631	23429
LPG		626	684	748	817	893	977	1068	1168	1277	1397	1528	1672
Kerosene		189	204	222	240	261	283	308	334	363	394	429	466
Fuelwood Consumption by Households		210249	227731	246757	267469	290022	314585	341343	370499	402275	436912	474678	515862
Informal Sector Fuelwood Consumption		37845	40992	44416	48144	52204	56625	61442	66690	72409	78644	85442	92855
Household + Informal Sect. Fuelw. Cons.		248094	268723	291173	315614	342226	371210	402785	437189	474884	515557	560120	608717

OUAGADOUGOU	Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Fuelwood	0,622Kg/per/day	376139	413301	454135	499004	548306	602478	662003	727409	799277	878246	965016	1060360
(addit. consumption of informal sector)		67705	74394	81744	89821	98695	108446	119161	130934	143870	158084	173703	190865
Charcoal	0,022Kg/per/day	13304	14818	16063	17650	19393	21310	23415	25728	28270	31063	34132	37505
LPG	0,950Kg/per/day	1574	1729	1900	2088	2294	2521	2770	3044	3345	3675	4038	4437
Kerosene	0,210Kg/per/day	348	382	420	462	507	557	612	673	739	812	893	981
BOBO-DIOULASSO	**Year**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Fuelwood	0,654Kg/per/day	144623	154935	165982	177816	190495	204077	218627	234216	250915	268805	287971	308504
(addit. consumption of informal sector)		26032	27888	29877	32007	34289	36734	39353	42159	45165	48385	51835	55531
Charcoal	0,048Kg/per/day	10615	11371	12182	13051	13981	14978	16046	17190	18416	19729	21136	22642
LPG	0,376Kg/per/day	228	244	261	280	300	321	344	369	395	423	454	486
Kerosene	0,210Kg/per/day	127	136	146	156	168	180	192	206	221	236	253	271
KOUDOUGOU	**Year**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Fuelwood	0,641Kg/per/day	19481	20148	20837	21549	22286	23048	23837	24652	25495	26367	27269	28201
(addit. consumption of informal sector)		3507	3627	3751	3879	4012	4149	4291	4437	4589	4746	4908	5076
Charcoal	0,034Kg/per/day	1033	1069	1105	1143	1182	1223	1264	1308	1352	1399	1446	1496
LPG	0,336Kg/per/day	28	29	30	31	32	33	34	35	37	38	39	41
Kerosene	0,210Kg/per/day	17	18	19	19	20	21	21	22	23	24	24	25
OUAHIGOUYA	**Year**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Fuelwood	0,810Kg/per/day	20539	21403	22305	23244	24222	25242	26305	27412	28566	29769	31022	32328
(addit. consumption of informal sector)		3697	3853	4015	4184	4360	4544	4735	4834	5142	5358	5584	5819
Charcoal	0,017Kg/per/day	431	449	468	488	508	530	552	575	600	625	651	678
LPG	0,000Kg/per/day	0	0	0	0	0	0	0	0	0	0	0	0
Kerosene	0,210Kg/per/day	15	15	16	17	17	18	19	19	20	21	22	23
TOTAL 4 CITIES	**Year**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Charcoal		25383	27508	29818	32331	35065	38040	41277	44801	48638	52816	57365	62321
LPG		1830	2002	2192	2399	2626	2876	3149	3448	3776	4136	4531	4963
Kerosene		507	552	601	654	712	775	845	920	1003	1094	1192	1300
Fuelwood Consumption by Households		560782	609787	663258	721613	785308	854845	930772	1013688	1104253	1203186	1311278	1429392
Informal Sector Fuelw. Consumption		100941	109762	119386	129890	141356	153872	167539	182464	198766	216574	236030	257291
Household + Informal Sect. Fuelw. Cons.		661723	719549	782645	851503	926664	1008717	1098311	1196152	1303019	1419760	1547308	1686683
Implicit fuelwood Consump. from Charcoal		70508	76410	82828	89809	97403	105666	114659	124448	135105	146710	159348	173115

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1988
Total Fuelwood Demand, 4 Cities	275574	298397	323229	350252	379666	411692	446568	484558	525945	571047	620205	673796
Total Fuelwood Demand, other Cities	55899	57688	59534	61439	63405	65434	67528	69689	71919	74220	76595	79047
Total Urban Demand	331473	356086	382763	411691	443071	477126	514096	554245	597864	645267	696801	752843
Total Rural Demand	2689212	2758222	2827873	2898038	2968572	3039312	3110071	3180637	3250774	3320214	3388657	3455765
Total Fuelwood Demand	3020686	3114308	3210636	3309729	3411644	3516438	3624166	3734883	3848638	3965481	4085457	4208608
Construction Wood	500000	517500	535613	554359	573762	593843	614628	636140	658405	681449	705299	729985
Total Wood Demand	3520686	3631808	3746248	3864088	3985405	4110281	4238794	4371022	4507043	4646930	4790757	4938593

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Fuelwood Demand, 4 Cities	732231	795959	865473	941312	1024067	1114384	1212970	1320600	1438124	1566470	1706656	1859798
Total Fuelwood Demand, other Cities	81576	84186	86880	89661	92530	95491	98546	101700	104954	108313	111779	115356
Total Urban Demand	813807	880145	952353	1030973	1116597	1209875	1311516	1422300	1543078	1674783	1818435	1975154
Total Rural Demand	3521164	3584432	3645100	3702648	3756493	3805989	3850420	3888990	3920816	3944922	3960225	3965529
Total Fuelwood Demand	4334970	4464577	4597454	4733621	4873089	5015864	5161936	5311290	5463894	5619705	5778660	5940683
Construction Wood	755534	781978	809347	837674	866993	897338	928745	961251	994894	1029716	1065756	1103057
Total Fuelwood Demand	5090505	5246555	5406801	5571295	5740082	5913201	6090681	6272541	6458789	6649420	6844416	7043740

FACTORS INFLUENCING URBAN HOUSEHOLD ENERGY DEMAND

1. The ESMAP/MET urban household consumption surveys provide important insights into the underlying factors influencing urban household energy demand. This analysis has highlighted the need to pay close attention to the determinants of consumer behavior when fine-tuning Burkina's urban household energy sector strategy, if improved results are to be obtained. The details of those factors are set out in the paragraphs below.

Household Size

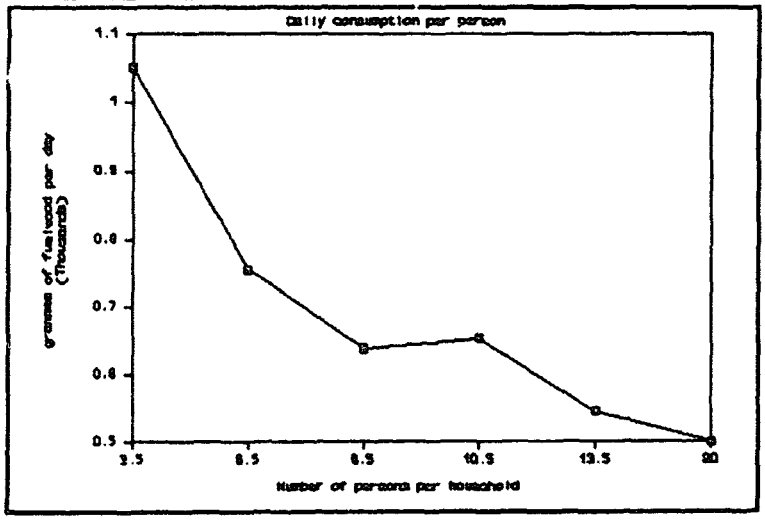
2. Family size is a significant determinant of the level of per capita consumption of household energy other than electricity as depicted in figure A2.1 below.

(a) A Ouagadougou household of 8.5 persons (average urban household size) consumes, on average, 638 grams of fuelwood per person per day.

(b) In smaller households, per capita consumption is substantially higher: 755 gram per person per day (+ 18%) for a household of 6.5 persons.

(c) In larger households consumption is smaller: 545 grams per day and per person (- 15%) for a household of 13 persons. 64/

Figure A2.1: Household Size and Energy Consumption



3. Because of the important economies of scale in energy consumption, demographic changes leading to smaller household sizes will increase per capita consumption of household energy. If, for example, average household size would decrease by one person from the present 8.5 to 7.5 persons in 2000, the consumption of household energy would increase by 10%.

64/ *No correlation was found between household size and average income per household.*

Individual Household Behavior

4. While there is a clear relationship between income and energy consumption at the macro level, the level of consumption of individual households varies considerably 65/ because of (i) differences in individual behaviour vis-a-vis to fuel savings and (ii) individual differences in eating habits. The main policy implication of these differences in energy consumption is that total consumption can be reduced by public education campaigns that stimulate energy saving habits and new food preferences.

5. Table A2.1 shows the range of energy saving measures in households by frequency. Although use of water to extinguish the fire after cooking/heating is the most widespread energy saving habit, it is surprising that little more than one third of the households apply this measure. Since 31% of the households cook outside the house in areas that are not protected from the wind, the low percentage of households that protect the fire against the wind is also revealing.

Table A2.1: Energy Saving Behaviour in Urban Households

Use of water to extinguish fire	37%
Use of improved stoves	35%
Reduc. amount of fuelw. after lighting	26%
Reduction in number of cooked meals	13%
Protection of fire against wind	9%
Other measures	16%

Source: ESMAP/NET household energy survey 1987

6. These figures suggest that the widespread assumption that low-income (and even middle-income) households are efficient users of fuelwood for cooking is, at a minimum, doubtful. Indeed, there is information to suggest that efforts to instruct the urban population on more efficient cooking methods, which is not now a part of Government's campaign, could generate fuelwood savings that could at least equal those resulting from the efficient utilization of the improved stove. This type of marketing campaign could reach well beyond the population currently addressed by the improved stove program, touching nearly all urban households: those who have an improved stove but use it inefficiently; those who can afford to buy an improved stove but have not yet done so; and those who can not afford or are not ready to buy an improved stove (the majority at the present time) but could realize fuelwood savings with improved traditional cooking methods.

7. Cooking habits tend to be rather uniform within income groups. The typical Burkinabe diet is extremely energy intensive. 66/ The staple food is "tô", a millet-based porridge and sauce, shown in figure A2.2 below. The Government does not now seek to promote an increase

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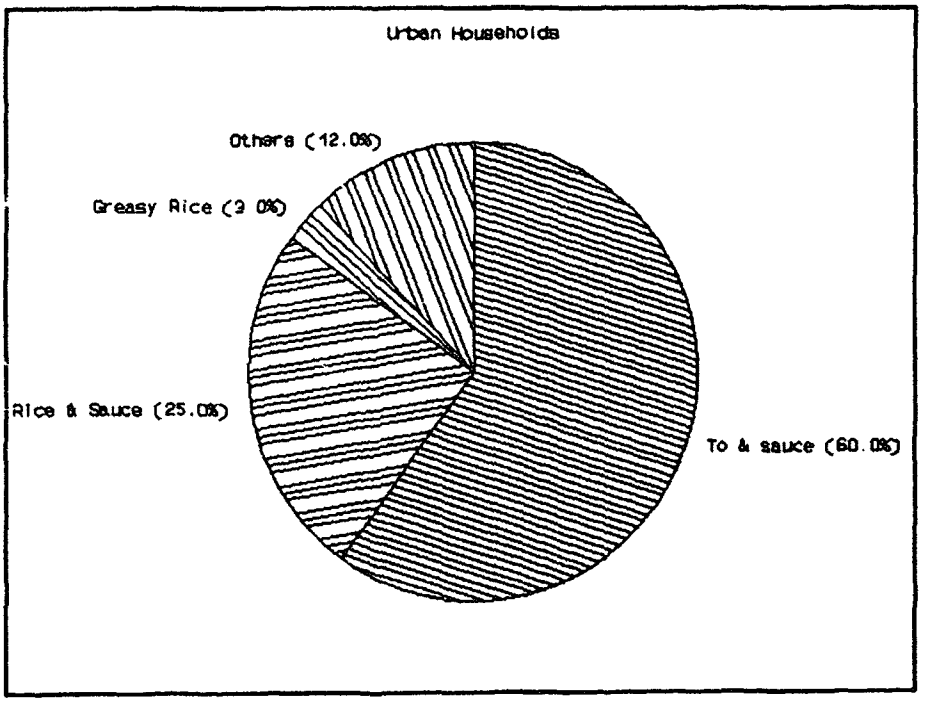
65/ *The correlation coefficient for the household size-energy relationship shown in figure A2.1.*

66/ *ESMA/IBE cooking tests revealed a consumption of 161 gr. fuelwood/person/meal for the tô and sauce, 140 gr for the rice and sauce, 158 gr. for the fried rice and 153 gr. for others.*

in the household demand for agricultural products to provide markets for surplus agricultural output (e.g. tomatoes normally exported abroad). If it did, an important side benefit of a successful campaign to increase the consumption of these products will be energy savings, provided, of course, that the meals that are promoted are less energy consuming as the present ones.

Figure A2.2: Frequency of Different Types of Meals



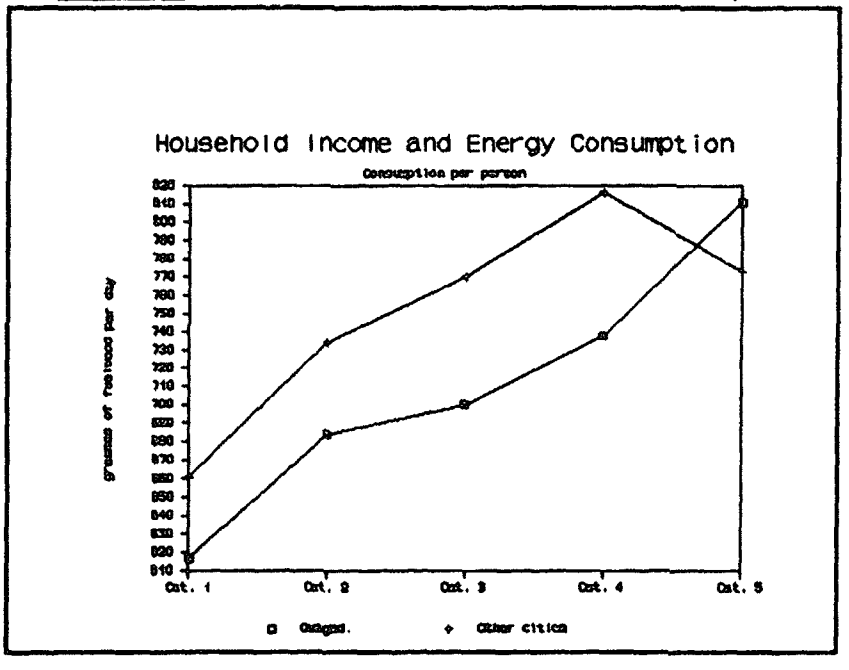
Household Income

8. Consumption of household energy rises with increasing income: Going from the poorest to the richest category of households, the fuelwood/per capita consumption increases by about a third in households that use fuelwood as their exclusive fuel (see figure A2.3). 67/ Since income in the former category is 10 times as high as in the latter, the income elasticity measured over this range is a low 0.03. Between the first (20,000 CFAF) and the second income category

67/ *Since the objective was to analyze the impact of rising income on the level of overall energy demand, households making use of substitute fuels for some of their cooking needs were excluded from the sample.*

(20-49,000), income doubles and fuelwood demand increases by 11%, implying an income elasticity of 0.11. 68/ The weighted average of the income elasticity found in the different income groups is 0.07.

Figure A2.3: Impact of Household Income on Energy Consumption



9. The low income elasticity of household energy demand relates to the fact that household energy consumption satisfies a basic need -- food preparation. 69/ Seen within the perspective of the impact of economic growth on the demand for fuelwood, the low income elasticity of household energy demand is somewhat reassuring. If, as expected, per capita income in Burkina Faso grows by 1.5% a year up to 2000, the rise in income will increase household energy demand per capita by only 1.5 per cent. Since some fuel substitution will be induced by the rise in income, the impact on fuelwood demand will be slightly lower still.

68/ *Figure A2.3 may underestimate the real income sensitivity of energy demand. It is likely that budgetary constraints force poorer households to be more attentive to energy savings. But as the survey measured energy consumption indirectly through information on the level of end-uses and average efficiencies of appliances, behavioural differences between income groups with regard to "energy efficiency" could not be captured and are thus not reflected.*

69/ *The income elasticity for the fuels not included in the survey i.e. electricity and gasoline, is a different story. The former is linked to the purchase of luxury appliances, the latter to private car transport (also a luxury). Both are highly income dependent.*

Table A2.2: Expenditure on Fuelwood in Percent of Household Income

Income Group	% of Income
< 20,000 CFAF	29%
20-49,000 CFAF	11%
50-99,000 CFAF	7%
100-149,000 CFAF	4%
> 150,000 CFAF	2%

Source: EMAP/MET Household Energy Survey 1987

10. However, the low income elasticity of household energy demand has negative social implications: fuelwood expenditures impose a heavy burden on the budgets of low-income families. Households with monthly incomes below 20,000 CFAF 70/, which do not have access to self-collection of fuelwood spend more than one-fourth of their income on the purchase of fuelwood. 71/ Households with more than 150,000 CFAF in monthly revenue spend less than 2% of their income on fuelwood, in part because household energy consumption (electricity excluded) rises less than household income, in part because of increased use of substitute fuels.

The Price Elasticity of Household Energy Demand

11. A low price elasticity is another feature of the basic needs aspect of household energy demand: A high increase in fuel prices will reduce total fuel demand by a rather modest amount. For example, in 1985, in response to a doubling of fuelwood prices in Ouagadougou, demand fell an estimated 30%. This large fall was linked to temporary supply constraints caused by a Government imposed reorganization of the fuelwood supply system. Once the supply of fuelwood became normal, demand picked up rapidly.

12. Unfortunately, no time series data on fuel prices and consumption exist in Burkina Faso. Instead, one has to look for clues to the response of fuel demand to prices by comparing the average level of consumption in high and low price areas. The price of fuelwood in Ouagadougou (25 CFAF/kg) is 60% higher than in the other three major cities - Ouahigouya, Koudougou and Bobo-Dioulasso (15 CFAF/kg); and the demand for fuelwood is 9-10% lower per person. This lower level of consumption supports the assumption that the demand for household energy is price elastic - in the range of -0.15. It does not prove the point, however, since other factors influence differences in regional consumption as well. On the other hand, the methodology used to calculate

70/ *At end-1987, the average wage of a civil servant was CFAF 119,000 per month; the legal minimum wage is 21,000 CFAF.*

71/ *This reported share is too high to be completely plausible. It is illustrative, however, of the magnitude of the problem. It also illustrates one of the weaknesses in household surveys: respondents have a tendancy to underestimate their income. Income in kind is often not included.*

the level of fuel consumption does not capture the effect of price on energy saving behaviour. It can be postulated that the two factors cancel out each other. If the assumption is correct, a doubling of fuelwood prices will reduce the demand in fuelwood consuming households by 15% (impact of the "own price elasticity" of the fuel). Total demand should fall even more, as some families will switch to other fuels such as LPG (impact of price increase on the relative price of the fuel).

ANNUAL FINANCIAL COST OF COOKING BY TYPE OF FUEL, FAMILY OF SIX PERSONS OUAGADOUGOU, 1987

	Fuelwood 3 Stones	Improved Stove	Charcoal	LPG (faitou)	LPG (IBE)	Kerosene (actual pr.)	Kerosene (official pr.)
Consumer Price (CFAF/kg)	25	25	86	330	330	240	160
Calorific Value (Mcal/kg) kerosene = liter	3,8	3,8	7	10,7	10,7	8,3	8,3
Energy Efficiency of Stove	0,14	0,2	0,2	0,29	0,37	0,4	0,4
Useful Energy (Mcal/kg)	0,53	0,76	1,4	3,1	3,96	3,32	3,32
Consumer Price of Useful Energy (CFAF/Mcal)	46,99	32,89	61,43	106,35	83,35	72,29	48,19
Annual Consumption of Useful Calories per Household (Mcal)	780	780	780	780	780	780	780
Annual Fuel Expenditure	36654	25658	47914	82952	65016	56386	37590
Expenditure Relative to 3 Stone	1	0,7	1,31	2,26	1,77	1,54	1,03
Price of two Stoves (CFAF)	0	1500	700	16400	16400	20000	20000
Lifetime (years)		3	3	6	6	6	6
Annual Amortization of Stove Price (at 15% rate of interest)	0	657	307	4333	4333	5285	5285
Deposit/Price for Two 3kg Bottles	0	0	0	14000	14000	14000	0
Annual Financial Cost of Bottles (15%)	0	0	0	2100	2100	0	0
Annual Cost of Wick Replacement						2600	2600
Total Annual Cost of Equipment	0	657	307	6433	6433	7885	7885
Total Annual Expenditure on Cooking	36654	26315	48221	89385	71449	64271	45475
Total Expenditure Relative to 3 Stone	1	0,72	1,32	2,44	1,95	1,75	1,24
Expenditure Relative to Impr. Stove	1,39	1	1,83	3,4	2,72	2,44	1,73

THE SECURITY OF SUPPLY FOR KEROSENE AND FOR LPG

1. Sufficient sources of supply of substitute fuels are available in the region. In 1985, the Government established the national oil company, SONABHY, giving it the monopoly for the importation and the storage of petroleum products. Until that date LPG had been imported almost exclusively from the SIR refinery in Abidjan by the three oil companies Burkina & Shell (B & S) (by rail in wagons and by two 11 tons road tanker), Total (by rail in bottles) and Mobil (by trucks in bottles). B&S operated a manual bottling plant in Ouagadougou, which filled the gas from the rail wagons and road tanker directly into the bottles. The wagons served as the only storage capacity. To improve the security of supply of LPG (and of petroleum products in general), therefore, became the immediate priority of SONABHY.

2. LPG can be imported to Burkina Faso from purchases on the international market landed at the port of Abidjan or from refineries in the immediate neighbouring countries. The cost per ton of LPG freight depends on the size of the cargo, the distance from the port of entry, the number of ports to be visited by the tanker and the time spend on unloading, and on seasonal demand/supply imbalances. In 1987/88 the cost of shipping went up sharply, as one changed from a situation of oversupply for small tankers (less than 6,000 tons capacity) to a situation of scarcity (the rent per month for small tanker has increased from 150,000 to US$ 320,000). It varies from US $ 30 (the case of Japan for cargoes of 35,000 tons from the Middle East) to $ 450 (case of e.g. 200 tons cargoes to ports with primitive receiving facilities. The cost of freight per ton from the European market should be between US$ 40 and 100 delivered Abidjan in cargos of +/- 1,000 MT plus local port handling of US$10 MT. Because of the high cost of ocean freight for the small quantities of LPG in question, under normal circumstances, acquisition from local refineries having excess demand is the lowest cost solution for Burkina Faso.

3. A refinery that has gas in excess of local demand has two options. It can use the excess LPG in the refinery heating process as a displacement for fuel oil. In that case, the excess gas is valued at fuel oil equivalent. Alternatively, it can sell it on the international market. The FOB cost ex-European refinery of LPG has fluctuated in the last two years between US$ 100 to US$ 200 per MT. The high cost of ocean transport usually exceeds the extra sales realization that could be obtained on the European market, i.e. the "net-back" on the LPG at the level of refinery - price Northwest Europe minus freight - is lower than the price FOB offered by regional customers or the price of fuel/oil. Therefore, local refineries will be forced to look for consumers in the regional market and sell it at whatever price they can get as long as it exceeds the price of fuel oil equivalent. Burkina Faso has several options:

(a) Abidjan, where LPG can be acquired from the SIR refinery or GESTOCI, a parastatal company that handles petroleum product storage and has sea terminals as well as a 2,000 tons LPG tank. The SIR refinery was the historic source of supply for LPG and kerosene. The Government is a 6 percent shareholder in the SIR refinery. It also holds equity in RAN, the railroad serving both countries. The incentive for the Government to use this route of supply was negated SIR's refusal to price the product ex-refinery at something near import parity. Shortly after its establishment, SONABHY redirected LPG imports to the lower cost (50%) GHAIP

refinery in Tema, Ghana. 72/ In late 1986, GESTOCI agreed, in principle, to handle supplies at import parity cost for the countries which are involved.

(b) LPG is now imported mainly from the GHAIP refinary in Tema, Ghana, which is the lowest cost supplier in the region. The surplus of LPG production over national demand is considerable, and will remain so in the medium term future.

(c) Most of the LPG production at the new refinery in Port Harcourt, Nigeria will be consumed in Nigeria, but it can serve as a back-up source of supply.

(d) Two projects under study by international oil companies in the region could further improve the long-term situation of supply:

(i) Gulf Oil Gabinda is currently evaluating the feasibility of fraxctionating some of the LPG that it produces in association with its crude oil operations in Gabinda, Angola. It is possible that only the equipment and storage necessary to fractionate and handle enough gas to satisfy Angola's demand will be out in place. If, however, a larger project is decided, Gabinda could be a low cost source of commercial LPG in the region.

(ii) Shell is currently evaluating the construction of ocean receiving and storage facilities for LPG in Lome, Togo.

4. The security of supply situation of kerosene is equally as favourable. Burkina Faso can chose between (a) Abidjan (local production of the SIR refinery as well as international imports through GESTOCI), (b) international imports through STSL, the ocean oil products receiving terminal in Lome and finally, (c) the GHAIP refinery in Tema as a back-up source of supply (inland market demand in Ghana for kerosene is in balance with output).

72/ *From 140,000 FCFA/ton to 76,000 FCFA/ton. In 1988 the price dropped further to 51,000 FCFA (US$ 185/ton). In 1988 SONABHY reached agreement with SIR to change their export pricing to international prices. This opens the possibility to have a second supplier for security of supply reasons without having to pay excessive premiums for it.*

THE PRICE STRUCTURES FOR LPG AND KEROSENE

The existing LPG and kerosene price structures are set out below:

Postes	Dépôt Bingo	Dépôt Bobo
1. Prix CAF Burkina	75,000	75,000
2. Droit fiscal d'importation	8,925	8,925
3. Taxe statistique	2,100	2,100
4. Timbre douanier	661.50	661.50
5. Prélèvement CBC	791.50	799.08
6. Prélèvement ONAC	395.75	392.54
7. Total des droits et taxes	12,873.75	12,87.12
8. Transport Lomé-Bingo/Bobo	85,000	115,000
9. Coulage Transport	1,600	1,900
10. Transit + TPS/Transit	3,109.72	4,207.28
11. Passage Dépôt+TPS/passage dépôt	8,536.50	8,536.50
12. Coulage dépôt	3,457.48	4,057.71
13. Stock de sécurité	20,000	20,000
14. Fondsa de vulgarisation	10,000	10,000
15. Frais SONABHY	10,353.89	10,963.44
16. Frais de transport Bingo/Ouaga	6,000	-
17. Frais Sociétés pétrolières	23,639.92	23,639.92
18. Marge Sociétés pétrolières	8,000	8,000
19. Total des postes 8 à 18	179,697.51	206,304.85
20. Prix de revient importateurs	267,571.26	294,182.97
21. Péréquation	28,423.74	1,817.03
22. Prix de cession aux distributeurs	296,000	296,000
23. Marge distributeurs	34,000	34,000
24. Prix de vente détail/tonne	330,000	330,000
25. Prix de vente détail/b. de 12,5 kg	4,125	4,125
26. Prix de vente détail/kg	330	330

Source: Ministère du Commerce et de l'Approvisionnement du Peuple.

Structure de prix ex-Lomé
Dépôt Bingo

Postes	Super	Essence	Pétrole	Gaz-oil
1. Prix de cession/Lomé	5,956	5,866	6,500	5,970
2. Taxe statistique	28	27.01	22.84	23.25
3. Droit de douane	35	33.77	28.56	29.07
4. Droit fiscal d'importation	350.07	337.77	28.56	29.07
5. Taxe complémentaire	1,578.40	1,576	-	1,287
6. Taxe spécifique	2,300	2,300	500	200
7. Prélèvement CBC	42.06	41.61	44.78	42.13
8. Prélèvement ONAC	21.03	20.80	22.39	21.06
9. Total droits et taxes	4,354.56	4,336.91	984.15	1.852.52
10. Passage magasin douane (PMD)	36.85	35.55	39.12	41.53
11. TPS/PMD	8.08	7.80	8.58	9.11
12. Fonds d'action pétrolière	250	250	100	250
13. Stock de sécurité	530	530	530	530
14. Transport	3,570.72	3,570.72	3,570.72	3,570.72
15. Coulage transport	47.63	47.19	50.35	47.70
16. Transit frontière	107.12	107.12	107.12	107.12
17. TPS/transit frontière	23.51	23.51	23.51	23.51
18. Transit burkina	31	31	31	31
19. TPS/Transit burkina	6.80	6.80	6.80	680
20. Passage dépôt	450	450	276	450
21. TPS passage dépôt	98.77	98.77	60.58	98.77
22. Coulage dépôt	95.26	94.36	73.53	71.55
23. Frais SONABHY	600	570	300	550
24. Frais sociétés pétrolières	1,087.89	1,034.88	544.50	999.54
25. Marge sociétés pétrolières	247.53	236.23	137.70	208.44
26. Total des postes 10 à 25 inclus	7,191.16	7,093.92	5,859.51	6,995.79
27. Péréquation	9,701.28	8,651.17	1,656.34	8,041.69
28. Prix de cession dépôt Bingo/HL	27,203	25,948	15,000	22,860
29. Prix de cession dépôt Bingo/L	272.03	259.48	150	228.60
30. Frais livraison ville	3	3	3	3
31. Prix cession revendeur	275.03	262.48	153	231.60
32. Marge revendeur	9.97	9.52	7	8.40
33. Prix détail ville Ouaga	285	272	160	240

Source: Ministère du Commerce et de l'Approvisionnement du Peuple.

KEY ASSUMPTIONS FOR LPG AND KEROSENE PENETRATION

Key Assumptions for Year 2000

	Population	Pers./househ	Households
Ouagadougou	1,819,800	7.9	230,354
Bobo-Dioulasso	650,000	9.8	66,327
Koudougou	85,000	9	9,444
Ouahigouya	72,000	13	5,538
Banfora	125,000	8	15,625
TOTAL	2,751,800		327,289

	Use of LPG or Kerosene as Primary fuel	Secondary fuel
Use in LPG households	39%	61%
Use in kerosene households	39%	61%
Number of persons in households		
9% Penetration Case, LPG households	4	8
LPG promot. case, LPG households	7	8
Kero. prom. case, kerosene house	8	8
Annual LPG consumption in tons/household		
9% Penetration case	0.088	0.055
LPG promotion case	0.153	0.055
Kerosene consumption t./h.	0.178	0.058

	Fuel Consumption t/year	Fuelwood Replacement t/year Compared to Base Case Consumpt.	Fuelwood in percent of Household Fuelwood Consumption	of Growth in Fuelwood Consumption
Annual Household Consumption of LPG				
Base Case	2.070	0	.....	
LPG Promotion Case	8.586	45.615	7,5%	13,3%
LPG & Kerosene Promotion Case	6.778	32.959	4,5%	9,6%
Annual Households Kerosene Consumption	6.501	44.855	6,1%	13,1%
Combined Result from LPG & Kerosene		77.814	10,6%	22,7%

Grand Total for the Five Cities - Year 2000 Forecast

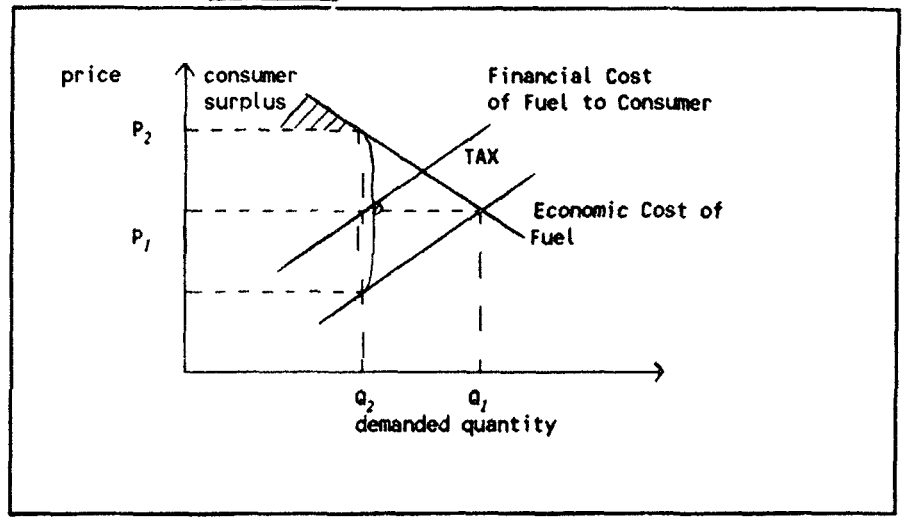
	Income Groups					
	I	II	III	IV	V	All Househ.
Distribution of Household (%)	22%	40%	26%	8%	4%	100%
Distribution of Household (numbers)	72.004	130.916	85.095	26.183	13.092	327.289

LPG users in % of Households	Income Groups					Ave. Penetr.
	I	II	III	IV	V	All Househ.
Base Case	1%	3%	12%	32%	55%	9%
LPG Promotion Case	1%	10%	50%	90%	90%	28%
LPG & Kerosene Promotion Case	1%	5%	35%	90%	90%	22%
Kerosene Users	5%	25%	30%	0%	0%	19%
LPG using Households:						
Base Case	720	3.927	10.211	8.379	7.201	30.428
LPG Promotion Case	720	13.092	42.548	23.56[illegible]	11.783	91.706
LPG & Kerosene Promotion Case	720	6.546	29.783	23.565	11.783	72.396
Kerosene using Households	3.600	32.729	25.529	0	0	61.858

THE ECONOMIC VALUE OF FUELWOOD SUBSTITUTION

1. LPG and kerosene for cooking are wanted by some consumers and satisfy a need for these consumers. Their welfare is enhanced by the superior comfort of these fuels compared to fuelwood. The economic value of the satisfaction of this "baseline" (or "spontaneous") LPG and kerosene consumption can only be analyzed from the standpoint of the satisfaction of consumer wants: It is equivalent to the financial cost of the fuel to the consumers plus the "consumer surplus" (defined as the difference between the total "willingness to pay" of the consumers and the total amount actually paid) (see Figure A7.1). At the margin, if some of this "spontaneous" demand were not met, a shortage of supply would have an economic cost, since it forces consumers towards consuming less desired fuels, and thus leads to a loss of consumer welfare.

Figure A7.1: Taxation and Consumer Welfare



2. There is no reason for society to totally discourage this kind of LPG consumption. "Spontaneous" LPG consumption should nonetheless be viewed as a luxury good and taxed accordingly. Consumers can spend their income on domestic goods, import goods, and on savings. If a consumer shifts consumption from woodfuels to LPG and kerosene, import expenditures increase. This is undesirable in a society like Burkina Faso which has substantial constraints to develop an export capacity that can match import requirements.

3. The calculation of the economic value of Government policies of LPG and kerosene promotion is a different matter. Here it is no longer a question of satisfying "spontaneous" consumer wants, but rather a conscious attempt to promote a switch in consumption. The reason for this must be that the marginal economic cost to society of the substitute fuels is lower than the marginal cost of fuelwood. To verify this assumption, the economic value of fuelwood has to be calculated. This value depends on the type of fuelwood consumption that is replaced - whether it is sustainable fuelwood production or unsustainable production.

4. As a first step, we can analyze the economic costs and benefits of replacing sustainable fuelwood production, of which there are two kinds: (a) fuelwood produced from managed natural forests and (b) fuelwood produced from plantations. In this report, the economic cost per ton of consumption and the import content (in parenthesis) have been calculated at 272,000 CFAF for LPG (63%), at 185,000 CFAF for kerosene (55%) 73/, at 25,000 CFAF (10%) for "managed natural forests" and at 36,000 CFAF (10%) for plantation fuelwood. Based on the substitution ratios of 1 ton of LPG = 7 tons of fuelwood, and 1 ton of kerosene = 6.9 tons of fuelwood, we can now compare the average direct economic cost of fuelwood with the average economic cost of LPG/kerosene. The result is shown in table A7.1.

Table A7.1: Results of Sustainable Fuelwood Substitution
(CFAF per ton consumption of substitute fuels)

	Managed Fuelwood		Plantation Fuelwood	
	net economic value	net impact on imports	net economic value	net impact on imports
LPG promotion	-77,000	-141,000	0	-134,000
Kerosene promotion:	-10,000	- 83,000	67,000	- 76,000

5. As expected, whether it replaces "managed fuelwood" or "plantation fuelwood", promotion of LPG and kerosene has a negative impact on the **balance of payments (imports)** - per ton of substitute fuel consumed; the net increase in import expenditure is between US$ 253 (kerosene) and US$ 470 (LPG) . As far as the **economic value** (which has been calculated at the market exchange rate of the CFAF) of the substitution program is concerned, it makes a difference whether the alternative to the program is plantation fuelwood or managed natural forest fuelwood. "Managed fuelwood" is clearly a more cost-effective form of sustainable household energy supply than either kerosene or LPG. This is not the case for "plantation fuelwood", unless the shadow rate for foreign exchange is set substantially higher than the market rate. Kerosene consumption has a lower economic cost than "plantation fuelwood". The economic cost of LPG consumption is identical to the economic cost of plantation fuelwood, therefore promotion of LPG in this case results in a no win, no lose situation. This result confirms the conclusion of the report, that **LPG and kerosene consumption should not be promoted to a point that sustainable fuelwood consumption is being replaced**. The forecasts for fuelwood demand and for fuelwood supply indicate that sufficient fuelwood is available to cover demand up to the year 2000 in a sustainable manner through natural forest management. Thus during the 1990s, modern fuels need only to be promoted as secondary fuels in households. In addition, we may conclude that if kerosene is a perfect substitute for LPG, it should be promoted as the preferred substitute fuel from both the foreign exchange and the economic cost point of view.

6. The calculations become more complicated when we evaluate the marginal value of modern fuel consumption that is promoted in order to eliminate levels of fuelwood consumption

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73/ *Economic price at the service station of 142,000 FCFA plus 30% mark-up at the retail level.*

that can not be covered by sustainable supply. In Burkina Faso, this will be the case for increases in urban energy demand after the year 2000. The objective of this marginal LPG and kerosene consumption is to arrest the decline in woody biomass stock. The welfare reason for this policy is (a) that a decline in woody biomass stock leads to a reduction in the provision of goods and services from this area, and (b) that it is thought that the value of this loss is greater than the cost of the substitute fuels.

7. The direct and the derived effects of a decline in woody biomass on the national economy and on welfare can be sumarized as follows:

(a) A **decline in woody stocks** will have two direct effects: (i) On-site, as a decline in the biological productivity felt, above all, in the level of sustainable fuelwood production, if fire, overcutting and overgrazing reduce the optimum and natural stocking rates of trees, shrubs and grasses; to a destruction of the soil mantle through the loss of vital organic matter and the leaching away of nutrients; and finally to increased risks for wind and water erosion; (ii) Off-site this environmental degradation makes itself felt through the loss of some difficult to quantify service benefits that include soil and water conservation and climate amelioration.

(b) The **reduction in sustainable fuelwood production**, in turn, will make itself felt at two levels: At the level of fuelwood prices, which will increase sooner or later and at the level of imports, where LPG and kerosene imports have to increase in order to make up for the sustainable fuelwood supply deficit (alternatively, investments in reforestation would have to be made; but these are, as we have seen above, uneconomic).

(c) The **increase in fuelwood prices** will in particular affect the welfare of the low-income urban population, who - in spite of efforts to use energy more rationally - will see the share of total expenditures allocated to fuel increase, resort to self-collection, reduce the number of hot meals and use lower quality fuels.

8. Based on the above, it can be concluded that the economic value of LPG and kerosene promotion in Burkina Faso is the sum of three benefits:

(a) The external economic benefits of the environmental value of standing woody biomass - due to the avoidance of increased rainfall runoff, stream siltation, reduced surface water quality, damage to aquatic ecosystems, and water lost to aquifer recharge.

(b) By maintaining a sustainable resource base, present day modern fuel consumption reduces enforced increases in the future level of modern fuel consumption, and/or avoids the need to develop new and higher cost sources of fuelwood supply. The value of the promotion program, therefore, is the difference between the net present value of the economic cost of increased LPG consumption in the short run and the net present value of the economic savings from a reduced LPG consumption in the longer run. The reduction in the future level of LPG production is determined by

(i) the difference in the annual productivity of managed woodlands and degraded woodlands and (ii) the LPG/fuelwood substitution ratio.

(c) The sum of the consumer surplus enjoyed by higher income consumers from the consumption of LPG/kerosene and of the low-income consumers that benefit from the lower long-run level of consumer prices on fuelwood.

9. There is no methodology available today to estimate the environmental and the consumer surplus benefits in a satisfactory manner. The second benefit is easier to estimate. On average, standing forest volume per ha in Burkina Faso is around 12.5 m^3 (= 10 tons) and annual productivity is around 0.83 m^3/ha (= 0.66 ton). For managed forests, the productivity figure will be higher; in the case of degraded woodlands it will be lower. But since this figure is not known, the 0.83 m^3 figure is used as a proxy for the difference in their levels of annual productivity. Since 1 ton of LPG replaces about 7 tons of fuelwood, its consumption protects the existence of 7/10 hectares of forest, able to sustain level of future fuelwood consumption of 0.46 tons per year. As a result of the higher level of sustainable supply, future annual LPG consumption can be 0.066 tons lower. Over a 30 year period, this will lead to a total savings of 2 tons of LPG consumption. The internal rate of return of this investment is 5.1 per cent. If the additional benefits environmental and consumer welfare were taken into account, the rate of return would be higher. This confirms the conclusion that LPG, after the year 2000, should be promoted as the dominant urban household fuel.

10. Expressed in monetary terms, the value of LPG and kerosene consumption which eliminates excess fuelwood consumption is as follows: in the first year, the net economic loss of 1 ton of LPG consumption is 77,000 CFAF and the increase in imports 141,000 CFAF. The lower level of future LPG imports permits annual savings of 5,100 CFAF in the net economic cost of supply and of 9,300 CFAF in imports.

DEFINING A SUSTAINABLE PRICING POLICY

1. A strategy for a pricing policy which is sustainable in the long term is outlined in figures A8.1 and A8.2 below. At the first planning step, energy planners must evaluate the level of woodfuel substitution needed at some future date to reduce woodfuel consumption to a sustainable level. In figure A8.1, the assumption is made that a 75% penetration rate for modern fuels is needed in urban households by the year 2000. The second step is to evaluate what relative price level (on a useful calorie basis) is needed between the substitute fuels and woodfuels to achieve this rate of penetration. This question is not easy to answer a priori, although "willingness to pay" surveys can provide a tentative answer. The experience from one country will not necessarily be applicable in another country. In one West African country, LPG replaced kerosene as the dominant urban household fuel, although the price of kerosene was a third lower; in another West African example, the price of LPG in the mid-1980s was on par with that of charcoal, and still LPG was used only as the secondary household fuel.

2. The needed price relationship depends, inter-alia, on the average level of income in the country. In the low income country of figure A8.1, LPG will reach the wanted rate of penetration at a price that is 80% of the woodfuel price; in the medium income country it will reach this rate even though LPG is 30 per cent more expensive.

3. The third step in the analysis is to identify the mix of increases in woodfuel prices and subsidies to modern fuels that are needed to gradually bring about the wanted change in relative prices. Figure A8.2 illustrates the case of a country at the beginning of the fuel cycle, where modern fuels have a higher price than woodfuels. Market forces alone will not bring about a sufficient change in the relative prices: the increasing scarcity of woodfuels leads to an upward pressure on prices, but the price of woodfuels in the year 2000 will still be lower than the cost of the substitute fuels.

4. The policy mix is based on two justifications: (a) Because of the existence of economies of scale in maritime transport and in the bottling of LPG the long-run marginal cost of LPG is lower than its cost at the beginning of the consumption cycle: As consumption grows toward the year 2000, the economic cost of LPG declines. A subsidy on LPG can be introduced in the year 1990 to bring the year 1990 consumer cost in line with the long run cost of supply. The subsidy can be decreased in line with falling costs and be phased out completely in the year 2000, when it is supposed, that the economies of scale are exhausted. (b) Taxes on woodfuels (e.g. stumpage fees and transport fees) should only be increased gradually, for both social and practical reasons. It takes time to put efficient control mechanisms into place. Until then, high rates of taxation will encourage corruption and increase the rates of return on uncontrolled black-market production. If this policy is implemented, the relative price of modern fuels changes gradually to reach the 0.8 ratio needed for the year 2000.

Figure A8.1: Relationship between the Rate of Penetration of Substitute Fuels and the Relative Price of Substitute Fuels to Woodfuels

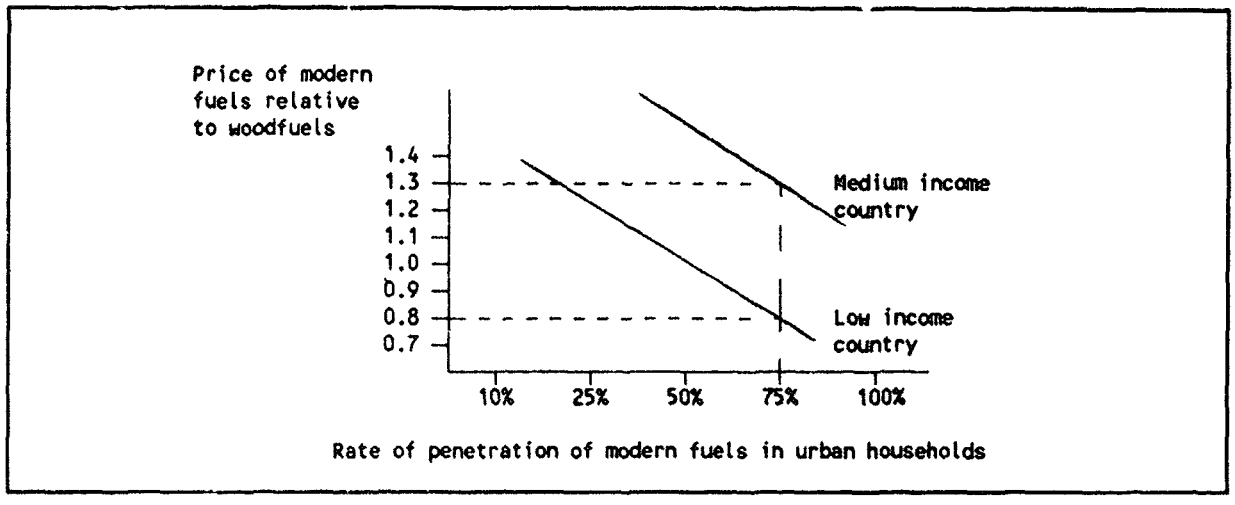
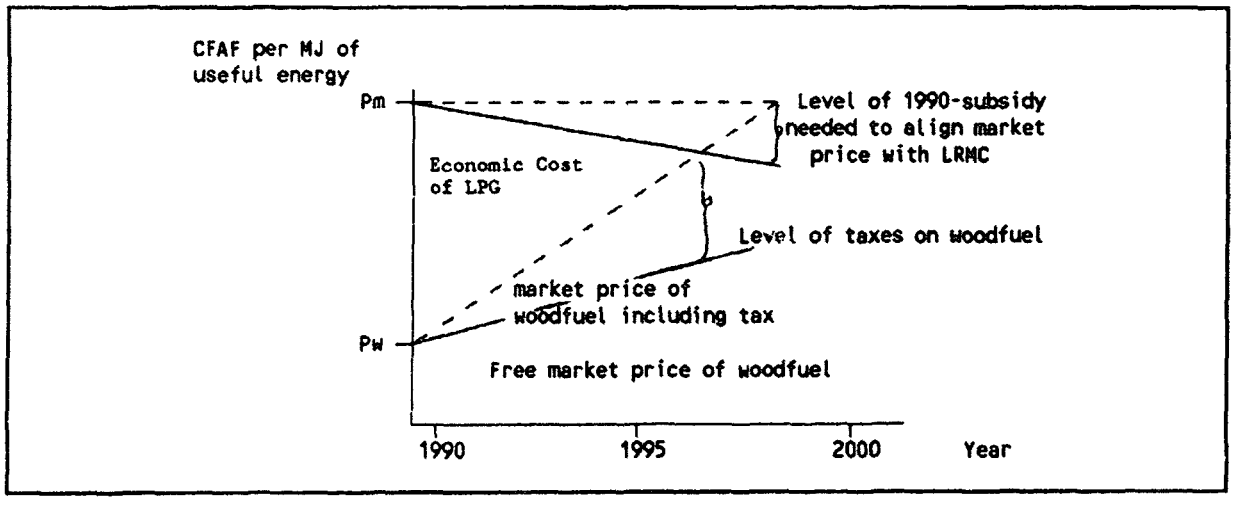


Figure A8.2: The mix of Decreasing Subsidies on Modern Fuels and Increasing Taxes on Woodfuels that is needed in Order to Obtain the Desired Ratio of Relative Prices in the Year 2000



LEGAL TEXTS

Décret du 23 octobre 1904 relatif au domaine public et aux terres domaniales (JORF du 26 octobre 1904, p. 6344 à 6345).

Décret du 18 juin 1912 sur l'exploitation des forêts de la Côte d'Ivoire (JORF du 21 juin 1912, p. 5477 à 5480).

Décret du 29 septembre 1928 réglementant le domaine public et les servitudes d'utilité publique en Afrique occidentale française (JORF du 31 octobre 1928, p. 11609 à 11610).

Décret du 26 juillet 1932 réorganisant le régime de la propriété foncière en Afrique occidentale française (JORF du 2 août 1932, p. 8451 à 8460).

Décret du 4 juillet 1935 fixant le régime forestier en Afrique Occidentale Française (JORF du 7 juillet 1935, p. 7289 à 7293. JOAOF du 3 août 1935, p. 611 - Rectificatif JOAOF du 14 septembre 1935,p. 723). Completé par le Décret du 12 avril 1954 (Article 23 bis) (JOAOF du 8 mai 1954, p. 844).

Arrêté Général No 2195 S.E. du 28 septembre 1935 définissant la limite Sud de la zone sahélienne et réglementant l'exploitation des forêts (JOAOF du 12 octobre 1935, p. 797). Complété en son Article 6 par l'A.G. No 3782 S.E. du 15 novembre 1938 (JOAOF du 26 novembre 1938, p. 140). Modifié en ses Articles 4 et 10 par l'A.G. No 3929 S.E. du 2 novembre 1942 (JOAOF du 14 novembre 1942, p. 999). Modifié en son Article 9 par l'A.G. No 794 S.E. du 27 février 1946 (JOAOF du 9 mars 1946, p. 287).

Décret du 12 avril 1954 complétant le Décret du 4 juilet 1935 (JORF du 16 avril 1954, p. 3715).

Arrêté Général No 3782 S.E. du 15 novembre 1938 réglementant les exploitations industrielles de bois de feu ou à charbon (JOAOF du 26 novembre 1938, p. 1401). Voir Arrêté Général No 2195 S.E. du 28 septembre 1935.

Arrêté Général No 3929 S.E. du 2 novembre 1942. Voir Arrêté Général No 2195 S.E. du 28 septembre 1935.

Arrêté Général No 794 S.E. du 27 février 1946. Voir Arrêté Général No 2195 S.E. du 28 septembre 1935.

Arrêté Général No 5307 P. du 9 décembre 1946 portant répartition du produit net des amendes, confiscation, restitutions, dommages-intérêts, contraintes et transactions en matière de police forestière (JOAOF du 24 décembre 1946,p. 1527). Modifié en ses Articles 1 et 3 par l'A.G. No 3619 S.E. du 27 juin 1951 (JOAOF du 7 juillet 1951, p. 991).

Arrêté No 1762 S.F. CH. du 30 décembre 1948 fixant certaines conditions d'application du Décret du 4 juillet 1935 sur le régime forestier et réglementant l'exploitation et la circulation des produits forestiers sur le territoire de la Haute-Volta (JOCI du 1 février 1949, p. 88 à 92). Modifié en son Article 12 par l'Arrêté No 546 APAS du 21 août 1953 (JOCI du 15 septembre 1953, p. 887 et 891).

Arrêté Général No 3619 S.E. du 27 juin 1951. Voir Arrêté Général No 5307 P. du 9 décembre 1946.

Arrêté No 10 A.P.2. du 10 janvier 1952 (taux des redevances d'exploitation forestière) (JOCI du 1 février 1952, p. 86).

Arrêté No 546 APAS du 21 août 1953. Voir Arrêté No 1762 S.F.CH. du 30 décembre 1948.

Décret No 55.582 du 20 mai 1955 relatif à la protection des forêts (JOAOF du 11 juin 1955, p. 1004 à 1006).

Délibération No 18.59/ACL du 5 février 1959 (taux des redevances d'exploitation forestière) rendue exécutoire par Arrêté No 66/PRES du 11 février 1959 (JORHV du 16 mars 1959, p. 201 et 202).

Arrêté No 1068/MF/MET du 1 juillet 1980 relatif aux taux de redevances d'exploitation forestière (bois de chauffage, de service, d'oeuvre, charbon de bois, permis). Modifié en son Article 3 par le Rectificatif du 7 avril 1981.

Rectificatif à l'article 3 de l'Arrêté No 1068/MF/MET du 1 juillet 1980 relatif aux taux de redevances d'exploitation forestière.

Ordonnance No 81-0012/PRES/MET du 3 juin 1981 portant interdiction des feux de brousse.

Arrêté No 326/MF/MET du 9 avril 1982 portant barême des prix des produits issus de la forêt naturelle et des plantations forestières.

Ordonnance No 83-021/CSP/PRES/DR du 13 mai 1983 portant statut des sociétés coopératives et des groupements villageois en Haute-Volta.

Ordonnance No 84-050/CNR/PRES du 4 août 1984 portant réorganisation agraire et foncière au Burkina Faso.

Décret No 85-144/CNR/PRES/ETOUR du 6 mars 1985 portant réglementation de l'exploitation du bois de chauffe et du charbon de bois au Burkina Faso.

Lettre No 317/MET/CAB/SG du 29 avril 1985 (objet: application des mesures relatives à la sauvegarde et à la consolidation de l'environnement).

Directive provisoire No 85-006/CNR/SGN-CDR du 8 mai 1985 relative à la délivrance des certificats provisoires d'agréments populaire aux débiteurs, grossistes-transporteurs et détaillants de bois de chauffe et de charbon de bois.

Circulaire à application provisoire No 33/CNR/MTC/CAB du 9 mai 1985 (fixant les normes techniques des véhicules habilités à transporter le bois à usage domestique).

Note No 468/CAPRO/DGP/DFPC du 10 mai 1985 (fixation des prix du bois de chauffe issu de la forêt naturelle et des plantations forestières).

Circulaire No 570/CAPRO/MET du 15 mai 1985 portant fixation des prix provisoires du bois au Burkina Faso.

Circulaire MET/CAPRO (qui prend effet pour compter du 1 juin 1985) portant réglementation provisoire de l'exploitation de bois et du charbon de bois au Burkina Faso.

Décret No 85-404/CNR/PRES du 4 août 1985 portant application de la réorganisation agraire et foncière au Burkina Faso.

Circulaire No 526/MET/CAB/DAFR du 11 juillet 1985 (application des nouvelles mesures sur l'exploitation forestière).

Ordonnance No 47/CNR/PRES du 29 août 1985 portant réglementation des feux de brousse, de l'exploitation du bois de chauffe et du charbon de bois et de la divagation des animaux domestiques.

Raabo No 12/MET/CAPRO du 11 juin 1986 portant suspension de la mesure sur la fermeture de la compagne d'exploitation forestière au Burkina Faso.

Raabo No 14/PRES/MET du 18 juin 1986 portant réglementation du transport du bois et charbon de bois au Burkina Faso.

Raabo du TRANS du 8 janvier 1987 portant institution des cahiers de charges du transporteur public burkinabé.

Zatu No AN.IV/023/CNR/TRANS du 6 février 1987 portant organisation des transports routiers au Burkina Faso.

Kiti No AN.IV/264/CNR/TRANS du 6 février 1987 portant réglementation de la profession de transporteur au Burkina Faso.

Kiti No AN.IV/265/CNR/TRANS du 6 février 1987 (transport routier).

Raabo No AN.V 47/CNR/BUD/REFI/ET du 24 août 1987 portant création d'un Fonds d'Equipement Forestier.

Recueil des textes applicables aux groupements d'intérêt économique du Burkina Faso.

URBAN FUELWOOD SUPPLY STRATEGIES

A. Ouagadougou

1. Principal fuelwood resources in the supply zone. Fuelwood comes into Burkina Faso's capital from the four major sources listed below.

(a) land clearing and wood cutting operations in the remnants of the previously uninhabited, Onchocerciasis-infested woodlands on both sides of the Nakabe (White Volta) River east and southwest of Ouagadougou. Most of these woodlands are being cleared by uncontrolled in-migration of farmers and by AVV development projects. Access is via the Ouagadougou-Niamey road and by the Ouagadougou-Po road;

(b) from managed and unmanaged natural forest lands adjacent to the Kabore Tambi National Park (this area includes the Forêt Classée de Nazinon where the FAO/BKF Project is operating). Access to this area is gained via the Ouagadougou-Po road and the Ouagadougou-Léo road;

(c) from domaine protege woodlands in the Bouyounou-Kassou area accessed via Sabou on the road to Bobo-Dioulasso; and

(d) from a wide variety of small scattered areas that are under an extended fallow or that could be classified as degraded woodlands.

2. Because of their distance from Ouagadougou, wood from the first three sources is transported almost exclusively by medium and small capacity trucks. Donkey carts, bicycles, pedestrians, and pickup trucks are the primary means of transport of fuelwood coming from the fourth source (which is usually at distances of less than 50 km from the city center).

3. The portion of the zone accessed by the road to Bobo-Dioulasso actually overlaps and competes with wood supply sources for Koudougou (over 100 km away). Within the next 5-10 years, all of Koudougou's supply zone will probably overlap with Ouagadougou's. This will occur as the latter city's demand grows and relatively easy access afforded by the road system around Koudougou allows wood merchants to travel farther afield.

4. Preliminary estimates indicate that the Ouagadougou-Koudougou supply zone had about 5.8 million tons of standing volume in commercial fuelwood species. This growing stock is on 1.5 million hectares of N, F, and M class lands scattered throughout the supply zone and does not include Kabore Tambi National Park. Annual growth, or the amount of wood potentially available for fuelwood removal on these lands, was estimated at 514,000 tons, an amount barely sufficient to satisfy the two cities' needs (under the average population growth assumptions) in the year 2000. Land clearing by that date, however, is apt to have eliminated significant amounts of the remaining natural forest land, unless it can be controlled. Although there is still some potential for Ouagadougou to continue to expand its supply zone beyond the area mapped, there are clearly limits to the extension (e.g., the Ghana border).

Current Fuelwood Management

5. The vast majority of the fuelwood supplied to Ouagadougou comes from unmanaged lands. Less than 10 percent, by one estimate, comes from managed woodlands. The Nazinon National Forest (22,000 ha of natural forest) and about 9,000 ha of planted exotic species elsewhere represent the total area of forest land currently under management in Burkina Faso. Using the median 1990 consumption estimates, this means that more than 170,000 tons are coming from sites where there is little or no concern for sustainable production. With the Government behind the effort to organize wood producers into cooperatives, there is now more of an economic incentive for local populations to have woodlands under a sustainable production plan. Two instances where this is already happening in the Ouagadougou wood supply zone are discussed below.

6. The BKF Project. The FAO effort, (Projet BKF/85/011, l'Aménagement et Exploitation des Forets pour le Ravitaillement de Ouagadougou en Bois de Feu) has organized, in its two years of operation, 19 or more forest management cooperatives (with about 500 total members) to be directly involved in the management of 22,000 ha in the Nazinon National Forest. Rotation age for the fuelwood growing in this forest (located in the tall grass savannah zone) has been initially set at a very conservative 20 years. Fifty percent of the standing volume is removed during the first cut.

7. Wood cut by the cooperatives is sold to the transporter-wholesalers at the official producer price of 1610 CFAF per stère. This is collected by a BKF Project clerk from the transporter at a fixed point as the vehicle exits the operational cutting zone. Tax receipts are returned to the government and the cooperatives paid according to the number of stères cut. The cooperative's operating fund monies are used at the discretion of the cooperative. The forest management fund is used to hire cooperative members for forest management activities (road construction and repair, controlled burning, direct seeding, etc.). Project documents indicate that actual management costs to date have been covered by the 500 CFAF/stère collected from fuelwood sales.

8. Ten other groups have also been formed by the BKF Project and are cutting dead wood on domaine protege lands near Bouyounou. The Project has recently been extended and there are plans to bring a large contiguous block of 20,000 ha of natural forest lands under management in this area. Wood transporters are already entering this area through Sabou and are paying the official 1610 CFAF/stère price.

9. Two additional projects, currently in the planning stage, are also aimed at managing fuelwood resources on domaine protégé lands to the west and south of Ouagadougou. These are to be funded from outside sources and will be modeled after the BKF Project experiences.

10. Other organized harvesting efforts. A number of other woodcutter cooperatives operate within the supply zone. A particularly large one near the village of Zarsin, just east of Kombissiri, is very well organized with members from about 10 villages. It has benefitted from its proximity to the Ouagadougou fuelwood market and used its operating fund monies to purchase a tractor and a wagon. It has also just obtained a bank loan to purchase a truck. This group issues the transport permits to the transporters and collects the fuelwood tax for the Forest Service. The group has been known to report transporters who collect or purchase wood illegally. Wood is sold

at the official producer price leaving 1310 CFAF/stère for the woodcutters and the cooperative's operating fund. There is no management fund, nor are there any planned and implemented natural forest management activities. The group has harvested wood on villages or lands that don't belong to the cooperative. Left unchecked without a plan, this is a situation which could easily lead to serious inter-village conflicts.

11. It has been reported that the Forest Service provincial director in Ganzourgou, East of Ouagadougou, has recently begun collecting 800 CFAF for each stère transported. The fuelwood tax accounts for the first 300 CFAF of this amount and the other 500 CFAF is destined for forest management activities that have yet to be instigated.

Priority Areas for NFM in the Ouagadougou Supply Zone

12. Six areas within the present Ouagadougou supply zone have been designated as priority areas for natural forest management. They are delineated on the Ouagadougou forest cover maps. They are labeled with Roman numerals I through VI. The areas were identified according to the criteria outlined in Chapter VI for selecting priority zones and following discussions with provincial directors and other knowledgeable Forest Service staff.

13. Priority Area Ia, Ib. The first priority area (Ia and Ib) has been the source of a considerable volume of Ouagadougou's fuelwood. The transport distances into the city are relatively short (50-60 km), over an excellent paved road. These two factors combined with unchecked land use changes dictate that management of the remaining forest lands in this priority area should begin immediately.

14. The area delineated on the map (61,200 ha) has been subdivided in two. This was done primarily to distinguish between forest cover types. Area Ia is predominantly natural forest under cover classes N and F with a small portion in plantation (P). Most of this area falls within the official boundary of the Waye National Forest. This fact should make it relatively easy for the Forest Service to bring it under control and establish a management plan. Baseline data should also exist on the area, although it should be checked and updated.

15. Area Ib, immediately adjacent to Ia, is comprised primarily of lands under the J-C cover class. These are old fallow and wooded laterite plateau areas that were either never suited for agriculture, or have since been abandoned in favor of more productive agricultural land. They represent a considerable resource (39,000 ha) close to Ouagadougou and one where uncontrolled wood removal still continues. A management scheme with good protection and regeneration, combined with soil and water conservation activities, will make it more productive over the long term.

16. Standing volume of commercially usable fuelwood on natural forest lands with the N, F, and M classes is calculated as 74,208 tons for Areas Ia and Ib. This figure is based on volume estimates made by Cameratti (1983) and adjusted by the fuelwood assumed to be available in each cover class. These estimates do not include the plantations growing in Area Ia (4,100 ha), nor the wooded fallow/laterite areas (39,700 ha) in Area Ib indicated on the Ouagadougou supply map. Assuming that all wood in the commercial plantations contains a volume similar to the N class

designation and conservatively estimate that the J-C cover classes contain 25% of the estimated volume per hectare, another 53,000 tons of growing stock material can be added, for a total standing volume estimate of almost 180,400 tons.

17. Potential total growth from N and F class land (17,400 ha) on Area I is estimated at 7,350 tons/year, although this would not all be available, under a management plan. Assuming that cover class and areas have remained the same since the satellite imagery was taken (1987), some hypothetical projections about fuelwood removals in a managed and protected area are possible. For Area I, the management scenario gives an estimated 4,100 tons of fuelwood that could be removed in the first year. If management were started today, removals from the N and F areas would grow to almost 6,900 tons/year by the year 2000 (e.g., in 10 years), and to more than 8,400 tons/year by 2005. The commercial plantations and the old fallow/laterite areas are also not included in these fuelwood yield estimates which appear. These two cover classes area significant part of the priority area. Protecting and managing them for fuelwood will also add to available yield estimates.

18. Priority Area II. Priority Area II is almost totally within the White Volta National Forest, an area that was essentially removed from the Forest Service's jurisdiction and put under the AVV river basin authority for development. Discussions with MET personnel indicate that the future of AVV is very uncertain and that AVV lands may be reassigned to existing ministries. The Forest Service needs to act quickly to consolidate the remaining woodlands of the White Volta National Forest and to bring them under management.

19. The satellite imagery of 1987 indicates that a large part of the lands falling inside the boundaries of the national forest have been cleared. Most of the remaining forest land in the forest and in Area II is in either the N (29,700 ha) or the F (24,200 ha) cover class. A small portion (4,600 ha) is in the M class. Control of the current land clearing activities in the area should be an initial activity once the Forest Service re-establishes the forest boundaries. Staff should also take steps to ensure that any wood from cleared areas is fully captured for the urban market and not otherwise destroyed. Like Area I, this area is also within a relatively short distance of Ouagadougou (60-70 km) and accessible by the Ouagadougou-Po road or the Ouagadougou-Niamey road. These facts, its classification as a national forest, and the relatively good condition of the remaining forest land make it a logical choice for early efforts to bring it under management. Total standing volume for Area II in the N, F, and M classes is estimated as slightly more than 283,000 tons. These lands have an estimated annual production potential of 24, 710 tons of fuelwood per year.

20. The scenario for Priority Area II in the Ouagadougou supply zone assumes all 58,500 ha of these natural forest lands could be put into a management plan. Estimated yield the first year with 50% of the standing volume removed, would be about 15,700 tons. If protected and managed for fuelwood, annual yield after 10 years could be as much as 25,000 tons.

21. Area III is part of the proposed buffer zone for the Kabore Tambi National Park. Development of a management plan focusing on fuelwood production and protection activities can benefit the future of the Park. As a buffer it would prevent uncontrolled land use right up to the Park border as well as providing for continued use, sustained fuelwood production and a livelihood for the surrounding villages. This area has significant amounts of N classed land (35,500 ha) and smaller amounts of M (7,800 ha) class lands. The supply map also shows a fairly large strip (12,100

ha) of old fallow (J class) land. The whole area is readily accessible to transporters from the Ouagadougou-Po road, or from the Ouagadougou-Leo road. The 43,300 ha of natural forest are estimated to have a standing volume of 243,888 tons. Based on productivity estimates from Clement (1982), these lands have an estimated annual production of 23,000 tons of fuelwood per year. The 12,100 ha strip of fallow lands identified on the supply map is also capable of producing fuelwood.

22. The data analysis of the management scenarios for the city's Priority III area estimates that an additional 7,200 tons of fuelwood/year might be available from the fallow lands. This assumes that J class lands contain 25% of the estimated average volume (3.1 m3/ha) for natural forests and have 90% of their growth in commercial fuelwood species. Management and protection would not only increase available yields over time, but result in an upgraded (cover class) and healthier forest as well. This area is also well within the grass savannah zone which means that fire control will have to be an important management activity. The experience being gained by the BKF Project in Nazinon regarding controlled burning should be applied here as well.

23. Priority Areas IV, V, VI. The last three priority areas are the least populated and contain vast areas of natural forest within the domaine protégé. In-migration and land clearing, however, are rapidly decreasing these forest areas. They also tend to be the farthest from the market, or the least accessible. The Ouagadougou-Leo road, although classed as one of the primary roads in the country, has fallen into severe disrepair. Any improvements made on this route would make larger areas of fuelwood resources (primarily area VI) immediately more accessible. If this happens the priority for managing this area would be much more critical. These three areas (IV, V, and VI) encompass 85 percent of the N, F, and M class lands (695,300 ha) within the priority area established for the supply zone (but only 2 percent of the degraded and old fallow lands). They also contain 87 percent of the annual production potential that could service Ouagadougou's energy appetite. They are lower on the list simply due to the priority area selection criteria.

24. The 18,600 ha of N classed land near Bouyounou (priority area IV) is higher on the list due to its accessibility and the fact that it is still uninhabited. A good quality dirt road into the area means that transporters are more apt to search for wood here rather than travel over the riskier road surfaces leading into priority areas V and VI. The BKF Project has already started organizing woodcutter groups in this area and has recently received an extension of its mandate to include this in its management area portfolio.

25. Three forest management projects are underway or planned within or near this area. (This includes extension of the BKF Project into the Bouyounou area.) All three projects will attempt natural forest management within the domaine protégé, something which has not yet been done.

Additional Management Factors

26. The pilot project zone delineated on the Ouagadougou wood supply map presents important management alternatives for fallow and degraded lands (Classes J, C, and J-C on the map) close to the city center. Wood supplied to Ouagadougou from these areas appears to be significant, entering, uncontrolled, into the city in small quantities on foot, by bicycle, and in donkey carts. These lands offer an important technical challenge for resource managers and a tremendous economic opportunity for villagers living in the zone. It is designated as a pilot because the cover types it proposes to work within are very typical of areas surrounding the other three large cities

in the country. It is also similar to priority Area Ib. The pilot project zone is much closer (in contrast to the more distant natural forest area) and lies entirely within donkey cart transport distance. Members of a management cooperative in this area would not only be able to receive the producer price for any surplus fuelwood produced, but also bypass the middlemen and sell directly in the Ouagadougou retail market. With official prices of 4320 CFAF/stère (unofficial price is about 7000 CFAF/stère) there ought to be tremendous incentive to the development of sustainable fuelwood supply in this area provided any existing land and tree tenure issues are resolved in the management plan.

27. Local participation, as mentioned previously, is the key to ensuring the implementation of any fuelwood supply strategy. The local population must have a vested economic interest in the resource if it is to be maintained for the long term. There are a number of positive initiatives with local participation in organizing fuelwood marketing within the Ouagadougou wood supply zone. Cooperatives formed at Nazinon are already receiving direct monetary benefits from the wood cutting and forest improvement activities. There needs to be a more formalized arrangement, however, which will insure the control and use of the forest management fund after the BKF Project leaves. This is critical if the long term sustainability of the forest is to be maintained.

28. The large cooperative at Zarsin is also providing tangible benefits to its members. As mentioned above, however, this has often been at the expense of non-member villages. The group does not however occupy itself with forest management, nor is there any fund set aside from fuelwood sales to do so. Separate groups for each village under the umbrella of the larger cooperative would allow for more equitable participation and benefits distribution. At the same time a management fund also needs to be established, forest resources need to be mapped, and a management plan developed.

B. Koudougou

29. Principal fuelwood resources in the supply zone. There are three principal areas which supply fuelwood to Koudougou. The major supply zone is the old fallow and laterite areas within a 40 km radius of the city. It is estimated that up to half of Koudougou's fuelwood comes form this area. Surveys indicate that almost a third of all wood entering Koudougou is brought in by pedestrians, while half comes in by truck from greater distances. The remaining quantity (about 17 percent) arrives by bicycle or donkey cart.

30. A second supply zone is the string of nine national forests (see the Koudougou supply map) located along the Mouhoun River to the west and southwest of Koudougou. Most of these forested lands are rapidly being encroached upon by farmers. Sections of the Tiogo National Forest on the Dedougou road are being exploited by organized woodcutters' groups (one of which is a women's precooperative). Because the Mouhoun serves as a natural barrier to transporters, most of the fuelwood removals are from the eastern side of the river. Wood from the national forests of Baporo and Laba, located on the Ouagadougou-Bobo-Dioulasso road, is collected by wood merchants from both Ouagadougou and Koudougou. Other forests between Bapora and Tiogog are much less accessible and are largely outside the supply zones (for either city). They are, nevertheless, being invaded by farmers seeking arable land to cultivate. The third, and most distant, area is the domaine protege lands that are shared with Ouagadougou consumers in the Bouyounou

area. An excellent road system allows easy access to these areas for the larger trucks that transport the wood. This area was previously described in Ouagadougou Priority Areas IV and V.

Current Fuelwood Management

31. There are no formal attempts at fuelwood resource management that resemble the efforts in the Ouagadougou supply zone. A MET/The United Nations Sudano-Sahelian Office (UNSO) project has recently employed a forest manager to direct the development of management activities for the Tiogo National Forest. This action is significant as it marks another "first step" in planned activities for a government-controlled forest. The initial plan calls for a much more participatory approach and the formation of management cooperatives with people from villages surrounding the forest.

32. There are a small number of woodcutter groups operating within the supply zone. These groups sell their wood to transporters at the official producer price (1610 CFAF/stere). The cutting tax accounts for 300 CFAF of this amount and the group also receives 200 CFAF for its operating fund. The woodcutter receives the balance (1110 CFAF); there are no monies set aside for a management fund. As groups become organized in the Tiogo Forest, the forest manager needs to insure that a forest management fund is set aside. These monies could in turn be used to employ cooperative members to do the required management activities in the forest.

33. The fuelwood market in Koudougou is not dominated by a large number of wholesaler-transporters, as is the case in Ouagadougou. There are only 11 officially registered motorized fuelwood transport vehicles for the whole city and, according to Yameogo (1989), the number of wholesaler-transporters who regularly transport firewood is declining. The current number is probably adequate for the small demand. Consumers pay for their wood at the officially established retail price of 4320 CFAF/stère. The large quantities of wood brought into the city "unofficially", on bicycles, on headloads, etc. can sometimes bring a premium price approaching 6000 CFAF/stère. These higher prices are most likely to occur when motorized transporters have not been able to bring in wood, thus creating temporary shortages which drive up the price.

34. Fuelwood prices higher than those fixed by government legislation, however, are usually an exception in Koudougou. The official wholesale price received by truckers is thoroughly enforced. This is the probable explanation for the decrease in the number of motorized transporters: the official price has not changed since 1985 while inflation, transport distances, etc. have definitely increased.

Priority Areas for NFM in the Koudougou Supply Zone

35. Koudougou's lower population (about one-tenth the size of Ouagadougou) and the much slower rate of growth means that fuelwood demand is less and will remain relatively low. Consequently a much smaller area is needed to furnish Koudougou's fuelwood needs over the next ten years. Three areas have been identified as priority areas for natural forest management.

36. Priority Area I. The first area is the Tiogo National Forest located about 50 km from the city and accessible by a good gravel road. As mentioned above, UNSO, providing assistance to the MET, has already employed a forest manager to develop management activities for the forest in consort with the surrounding population. Controlling land clearing inside the forest's northern boundaries will be a preliminary hurdle. A plan based on a good map of the

forest and intended uses of various parts of the forest needs to be formulated by the provincial Forest Service staff with cooperative groups.

37. Much of the forest is still in good condition and over half of the total land area (18,800 ha out of 26,900 ha) is in the uninhabited N class. This factor, coupled with the excellent access and the fact that it is already under Forest Service jurisdiction, made it the logical choice to be the number one priority in the Koudougou zone. Total standing fuelwood volume for the whole priority area is estimated to be 141,900 tons (Table 6.2). Average annual growth on N, F, and M class lands within this area is estimated as 14,300 tons (Table 6.3). This is roughly equivalent to 80 percent of Koudougou's projected demand for 1990. Managing and protecting these lands specifically for fuelwood will increase this amount and make the forest more productive over the long term.

38. The management scenario (see Koudougou, Priority Area I) indicates that fuelwood yield from one 1,800 ha compartment on the forest would yield 7,800 tons of fuelwood in the first year, if one-half the volume were removed. Under management and protection, the trees on the same size compartment will grow to yield as much as 16,200 tons after 15 years.

39. Priority Area II. The second priority area also encompasses Government-controlled lands: the Baporo and Laba National Forests. The Forest Service needs to exercise its jurisdiction over these lands and control the land clearing activities that are seriously threatening the long term forest productivity of the area. It is a situation similar to Area I: the forest is in good health overall, but without a rational plan for protection and development, the resource will quickly disappear. The excellent access afforded by the paved national highway between Ouagadougou and Bobo-Dioulasso already attracts wood merchants from both Ouagadougou and Koudougou. Reports and observations suggest that wood from the land clearing is not being wasted, but the supply under these conditions is not sustainable. Management of the forests and the fuelwood removals will insure a long term source of income for the small population of people in the area and funding to cover management expenses.

40. This area, approximately 20,000 ha, contains roughly equal amounts of N, F, and M class lands according to estimates obtained from the Koudougou cover type map. Standing volumes are estimated to be about 78,600 tons and the overall annual production from all three cover types is estimated at almost 11,000 tons. There are no plantations (P class) or fallow/laterite (J, C class) cover types in Priority Area II. Rainfall in this area is fairly good (850 mm/yr) increasing the chances for better regeneration from harvesting operations. The management scenario for Priority Area II lists the fuelwood yield on managed compartments to be 4,300 tons in the first year. Following 15 years of management and protection, the fuelwood harvest on the same size area would increase to almost 16,200 tons.

41. Priority Area III. The third priority area for Koudougou is an area of about 52,000 ha within a 40 km distance north of the city (see the Koudougou supply map). A substantial portion of the area outlined on the map is cultivated (0 cover class). There are also equal parts of fallow and ironstone lands (J and J-C cover classes) and some natural forest with the M cover class designation (27,500 and 24,100 ha respectively). Standing volume on the M class natural forest land is estimated as 47,700 tons. Annual growth from the M class lands alone is estimated to be almost 11,500 tons. Fuelwood yields that could be expected from a 3,440 ha managed compartment in this area would be 4,900 tons in the first year; after 15 years with protection and management, yield from a compartment could be as high as 17,600 tons.

42. Half of the wooded lands in Priority Area III are on old fallows. Due to previous community land use on these areas, a management system different from that which can be applied to natural forest areas will have to be used. In this example the community defines the land use priorities on their lands. MET staff professionals then adapt resource management activities to these priorities, focusing first and foremost on the profitability aspects for the local community.

43. Two additional sites, each having lower priorities than the three mentioned above, also fall within Koudougou's supply zone. They are the areas shared with Ouagadougou and designated as Areas IV and V for both supply zones.

C. Bobo-Dioulasso

44. Principal fuelwood resources in the Bobo-Dioulasso supply zone. Supplying fuelwood to the city's population is not the critical problem that it is in the other three cities. The higher rainfall, fewer people on the land, and a generally larger area of nearby natural forests means that the overall supply situation is much more resilient that the situations that exist in the other three urban areas. Consumers also have the luxury of being much more selective in terms of the species they burn for fuel. Although exact quantities are undetermined at present, considerable amounts of the current wood consumption arrive by foot and by bicycle from areas close to the city center. Donkey carts capable of transporting up to two stères per trip also transport substantial quantities of wood from areas within a 25 km radius of the city.

45. Donkey carts and all motorized transporters are required to be registered with the Forest Service. These registered suppliers transport wood to Bobo-Dioulasso from three areas: all three are connected with the city by good (paved or laterite) road systems (see the Bobo-Dioulasso supply zone map). The largest area lies to the east and southeast of town and is serviced by both the Ouagadougou road and the road serving the Kelesso region. Another, smaller supply area is reported to the northwest of the city in the region just to the east of Koundougou in an area bordering the Tere National Forest. The third is in a hilly region adjacent to (and just north of) the Bobo-Banfora road. Accessibility in this latter region is reported to be a major obstacle, consequently relatively little wood enters from this area.

46. Wood from all three regions is usually transported at distances ranging from 35 to 65 km, substantially less than the motorized supply routes for Koudougou and Ouagadougou. Other routes also supply some fuelwood, but road conditions are the primary limiting factor. The main road through Satiri to the Maro National Forest is a good example. Even though there are substantial amounts of wood available here (from land clearing activities in the forest), the Satiri road is in such disrepair that it discourages many transporters from trying to haul fuelwood back to Bobo-Dioulasso. Government policy makers should develop a plan for utilizing wood from land clearing operations in the event that transporters don't bring it to Bobo-Dioulasso.

47. Unless road conditions are improved in many areas of the supply zone the majority of the wood will continue to come from the most accessible sites, at least for the foreseeable future. This means that most of the pressure for fuelwood resources will remain on the first area discussed above and on the old fallow and degraded woodlands closest to the city limits.

Current Fuelwood Management

48. Very little effort has been expended to manage the fuelwood supply chain in Houet Province. Two or three producer groups do operate, but very little has been done to encourage their organization or focus on forest management. In Satiri, for example, group members act simply as middlemen. They buy wood from people in the region at the best price they can obtain and then sell it to the wholesaler-transporters. In Taga there is a producer group, but each member sells his own wood with no obvious advantages of belonging to the organization.

49. It is the wholesaler-transporters who represent the best organized part of the fuelwood chain into Bobo-Dioulasso. The wholesaler-transporters pay the fuelwood tax in the province, contrary to other urban supply zones where the woodcutter (or the producer group) pays. Some of these wholesaler-transporters are even able to maximize their advantage further by selling door-to-door in the city.

50. Other than registering wood transporters and collecting fuelwood and transport taxes, the Forest Service does little to manage fuelwood resources in the region. A stronger emphasis on natural forest management is definitely needed in the province including more aggressive enforcement of the recent legislation that affects fuelwood and fuelwood markets in the rest of the country. Current supplies appear to be adequate and official retail prices (3,000 CFAF/stere equivalent) are rarely surpassed in the city.

Priority Areas for NFM in the Bobo-Dioulasso Supply Zone

51. Although the overall fuelwood supply situation for Bobo-Dioulasso is good, there are areas that could definitely benefit from management activities to improve the overall productivity of the forest. The focus of the five priority areas discussed below is on improving the efficiency of the system and capturing the opportunities that currently exist.

52. Priority Area I. The first priority for managing natural forests in the supply zone needs to be at the Dinderesso National Forest. This 6,000 ha forest is comprised totally of N class natural forest (4,400 ha) and plantations (1,600 ha). The Forest Service has developed fire lanes within the forest and there has been essentially no violation of the forest boundaries by the adjacent population. The forest is also the site of the national forestry school. The forest is intact, it is in good condition with an estimated 30,000 tons of standing volume in commercial fuelwood species, and it is only 10 km from the city center. It is reported that management plans have been developed for Dinderesso in the past. These need to be updated and given a higher priority. The forest is well protected, but in order to be more productive, a complete management strategy needs to be developed. The relatively small size of the forest should lend itself easily to management by compartments. Dinderesso represents a unique opportunity for the Forest Service, or the forestry school staff/students, to work with the local population to manage the forest.

53. Annual productivity, is estimated to be about 3,800 tons for Priority Area I. This is only a very small portion of the current total fuelwood demand (106,400 tons) for the city, but it represents one of the best opportunities in the country to develop a forest management model and demonstration area. The nearby market for fuelwood in Bobo-Dioulasso should also enhance working on a for-profit enterprise with the local population. The short distance into the city also means that cooperative members could transport the wood themselves and realize even greater

profits. The management scenario for Priority Area I gives an estimated fuelwood harvest of 2,240 tons in the first year on a 400 ha compartment. Assuming continued protection and current growth rates, 5,300 tons could be removed 15 years hence.

54. Priority Area II. The second priority area is also a national forest (Koulima) within 10 km of the city. It is much smaller (1,800), however, and not in as good condition. The remaining natural forest is in the F cover class. Unlike the Dinderesso forest in Area I, substantial areas of Area II have been repeatedly cut over for fuelwood by the surrounding population. There appears to be no control over these wood removals, although the actual boundary has been respected in regards to agricultural land clearing. Regeneration of stump sprouts is vigorous and the number of stems per hectare is high (but the average height of the stump sprouts in areas nearest the city is less than two meters). Because of its degraded state, the standing volume estimate (7,900 tons) for commercial fuelwood listed in Table 6.2 may be high. An accurate inventory (and map) of the forest is needed as the management of the area begins.

55. Annual productivity of Area II remains high. Clement's equation, when applied to this rainfall zone (1,100 mm/yr), gives an estimate of 1,500 tons/year of commercial fuelwood for this cover (F) class. The area is obviously valued for its fuelwood and represents an opportunity for management with the local population. Its proximity to the city means that there should be a ready market for products from this priority area. The existing situation will facilitate the Forest Service in developing a management plan and a fuelwood harvesting schedule. The most difficult part will probably be protecting the forest from illegal cutting. Past patterns will be difficult to break, but establishment of a cooperative with the surrounding population will help to change that. Because they would receive direct cash benefits from the management activities, they will have a vested interest in making sure that the area is protected.

56. Once organized, members can take advantage of the short distance by transporting and selling fuelwood and other products to retailers or door-to-door themselves. There are no primary or secondary road systems in the area, but the tertiary roads and trails which crisscross the area are all easily accessible by donkey cart.

57. Priority Area III. The third priority area is within 50 km of the city center. It is located to the east of town and serviced by two good road systems. Area III does not encompass any national forest land, but there are substantial areas (42,700 ha) of natural forest cover (in the F and M classes) on domaine protégé lands. Total standing volume in commercial fuelwood species is estimated to be 116,200 tons on these natural forest lands. The fuelwood supply zone map for Bobo-Dioulasso shows some of this area to be old fallows (J class land). This area can also be assumed to have considerable amounts of commercial fuelwood species growing on it and should not be discounted when developing management plans. Annual growth of fuelwood species on the natural forest lands is estimated to be 37,000 tons/year using the assumptions stated in Table 6.3. Establishing management and protection activities in Priority Area III will insure that this productive potential is maintained and improved. Its easy access from the city means that fuelwood, if found here, will always be in demand.

58. There are no established boundaries (as in the previous two priority areas) that will facilitate management. But the relatively large contiguous area of natural forest with its productive potential and the configuration of the transport links (a major crossroad just outside the area) lends itself to management. Woodcutters also are obviously active in Area III as evidenced from the

wood now leaving it. All these factors when weighed together represent an excellent opportunity for developing a participatory management scheme for the fuelwood resources found there.

59. When the management model was applied to Area III, including the J class lands, potential fuelwood removals were estimated to be 7,450 tons in the first year. After 15 years with protection and normal growth the fuelwood harvest could be as high as 34,500 tons, almost a five-fold increase.

60. Priority Area IV. The fourth priority area is another national forest. This one, the Tere National Forest, just east of the town of Koundougou, is located about 70 km north of the city. This distance is relatively great for the Bobo-Dioulasso supply zone, but the paved road to Koundougou is in good condition. Forest Service personnel have indicated that wood merchants do travel to the area to obtain wood for the city. Two-thirds (7,700 ha) of the forest is classed as N lands on the cover type map. The remaining area (3,000 ha) has some portions that have been cleared for agriculture, but its F classification indicates that large tracts of natural woodlands still remain. By working with the surrounding villagers, Forest Service personnel can help ensure that the natural forest areas remain intact and productive. Standing volume estimates for the 10,700 ha are on the order of 65,000 tons for the natural forest areas. Annual productivity on these lands is estimated to be slightly more than 9,000 tons when the assumptions listed in the table are employed.

61. Like Priority Areas I and II above this area will lend itself to management fairly easily because of Forest Service jurisdiction over the area. It also represents a good opportunity because there is a relatively large block of contiguous forest that is little touched by land clearing. A market clearly exists for fuelwood and villagers should appreciate the opportunity that a management cooperative will offer in terms of direct cash benefits. The management fund will help to finance forest improvement activities and insure a sustainable supply of fuelwood.

62. Priority Area V. The last area to be considered as a priority for Bobo-Dioulasso's fuelwood supply strategy encompasses a large zone (90,400 ha) immediately outside of the city to the southwest along the Orodara road. Topography in the area is quite market, often punctuated by small, rocky outcrops and steep hillsides which make access into the area difficult. The lack of land clearing activity in the area is probably due to the inaccessibility and the thin soils which are ill-suited for agriculture. Most of it remains classed as N or F lands on the cover type maps.

63. The standing volume, not all of it accessible, is estimated to be 442,400 tons for the three cover classes of natural forest. Annual production on these lands is good because of the condition and untouched nature of the forest. Total annual growth for these 90,400 ha is estimated at nearly 79,000 tons. Under protection and normal growth conditions, the fuelwood harvest from a managed compartment 15 years hence would be 70,400 tons.

64. This last area represents an opportunity to improve the overall efficiency of the city's fuelwood supply and marketing network by reducing reliance on more distant fuelwood sources. Good transport links currently exist and organizing a fuelwood enterprise would bring more income to local villagers. Assuming that the management cooperative can provide substantial volumes of fuelwood at the start of the management process, management fund monies could be used to build roads that would access still more fuelwood resources.

D. Ouahigouya

65. Principal fuelwood resources. The lower average rainfall (500 mm/year) does not favor abundant natural regeneration and growth of current vegetation stocks. Most of the fuelwood currently entering the city by truck comes from trees that died during the last drought from area that are at least 60 km from the city.

66. The forest cover type and fuelwood supply map is characterized by large areas classed as O (or occupied) lands. Lands which still support a significant amount of natural forest vegetation are far from the city and in relatively scattered locations. Other than one area between Tiou and Tou northwest of the city, there are no large contiguous blocks of natural forests. Many of the natural forest areas that do remain are being cleared for agriculture. These appear as M class lands on the Ouahigouya map (indicating little forest cover and a predominance of agriculture). The entire zone is fragile from a land development standpoint. Soils are frequently shallow with considerable amounts of ironstone outcroppings. Historically, extensive agriculture in the region, coupled with the low rainfall, has led to an overall degraded condition.

67. Very poor road conditions exist throughout Yatenga Province. This means that transport costs for wood from the natural forest areas are higher than other cities in the country which benefit from better roads. Poor transport links also diminish the reliability of the supply from these sites. As a result very little fuelwood enters the city via motorized transport. A large portion of Ouahigouya's fuelwood comes into the city almost completely uncontrolled by bicycle, on headloads, and by donkey cart at all hours of the day. The exact supply areas are not well known and the Forest Service has no control over wood entering the city in this manner.

68. Any management efforts aimed at monitoring Ouahigouya's fuelwood supply network are frustrated by the low prices that are officially recognized for Yatenga Province. The 500 CFAF/stere after tax producer price in the Ouahigouya supply zone is less than one-half the price paid in provinces supplying Ouagadougou's fuelwood. All participants in the supply chain say that the prices being paid are not worth the effort. It is no wonder that there are only one or two motorized transporters still operating out of the city. If higher official prices were recognized there would be more registered (licensed) people (and/or groups) in the market arena and more of an opportunity for management.

Current Fuelwood Management

69. There are four woodcutter groups operating within the supply zone; all are exploiting dead wood from trees that didn't survive the 1983-84 drought. No attempts at forest management have been made by these or any other entity in the supply zone. Two of the woodcutter groups at Benh, and one at Tou northwest of the city on the Mali road are reported to supply the largest quantities. The supply distance is about 60 km on a poor quality laterite piste that is sometimes impassible during the rainy season. The two producer groups operating at Benh here are not really groups at all, but two individuals that hire young men from village to village to help them cut wood for the wholesalers. There are no long term provision for group benefits (a cooperative fund or a management fund) for either of the groups.

70. Another area to the northeast (Toulfe and Babo) is also accessible by the best dirt road in the region. Transport distances in this case are further, about 65-75 km. The third woodcutter group operating in the region is located at Toulfe; it is well organized. A fourth group at Babo no longer functions, primarily because the marketing conditions are so poor. All the producer groups are confronted with the same situation. Unless the price structure improves the woodcutters won't have sufficient incentive to collect wood (let alone manage the forest for long term supply); nor will it be worthwhile for the transporters to travel those distances in order to collect it.

71. As reported above, substantial quantities of fuelwood enter the city from nearby sources, transported by carts, bicycles, and on foot. The Forest Service in Yatenga province attempts to police this movement, but with little success. It is reported that transporters often stockpile wood supplies just outside the city and quickly move it in under cover of night, or when they know that Forest Service personnel are absent. These actions allow suppliers to avoid fuelwood taxes and any transport fees and licenses, and still take advantage of unofficial market prices which have been reported as high as 3,500 CFAF/stere (versus the official price of 2,100 francs).

Priority Areas for NFM in the Ouahigouya Supply Zone

72. Since there are no national forest lands within the supply zone, transport distance and road condition became the key factors in identifying priority areas for management. Management of any or all of the areas will only become viable if the producer price is increased to more accurately reflect real costs associated with fuelwood production. Before fuelwood management can occur in Ouahigouya's fuelwood supply zone substantial progress in the implementation of a revised fuelwood strategy must take place.

73. Priority Area I. The area northeast of the city near the towns of Toulfe and Babo is suggested as the number one priority. Besides being readily accessible by a good dirt road throughout most of the year, there are still substantial areas under natural forest cover. Most of these lands (see the Ouahigouya map), classed as F (9,400 ha) and M (36,900 ha), are in relatively small blocks. The producer group currently operating at Toulfe will facilitate organizational and management efforts in the area. Fuelwood growing stock resources are very difficult to estimate. The drought of 1983-84 killed a majority of the trees still standing. Annual productivity or growth, an indicator of the volume potentially available for fuelwood removals, was calculated. Productivity of commercial fuelwood species for Priority Area I is estimated as 9,800 tons/year. The removal of the drought-killed trees is almost complete.

74. Forest Service personnel need to organize the existing woodcutter groups into management cooperatives and begin to improve stocking and productivity on these lands. If agricultural practices are prevented from encroaching here, the productivity of the sites can at least be preserved, and maybe even enhanced.

75. Priority Area II. The second priority area encompasses lands within a 40 km radius of the city. It is recognized that much of the city's current fuelwood needs are met by the residents themselves. That is, farmers who live in Ouahigouya often return to the city carrying wood with them that they have collected from their own lands or elsewhere. Nearly all families in the city have fields in the surrounding area and collect wood from them.

76. Large areas of natural forest land are lacking (only about 39,000 ha), but there are substantial zones of fallow and uncultivated ironstone areas which support widely scattered, but significant quantities of woody biomass. In order to ensure longer term supplies from this area and to minimize the risk of further degradation, Ouahigouya decision makers need to develop a management scheme that will capitalize on the resources in the area.

77. Within this 40 km radius encompassed by Area II, there is some standing fuelwood volume on F and M class lands. It is estimated to be about 19,000 tons. These, too, present an opportunity for villagers living nearby. Annual productivity from these lands has been estimated as almost 8,000 tons. Members of organized cooperatives could also sell the fuelwood door-to-door and realize substantial profits from direct retail sales in the city. Before any marketing effort is conducted in conjunction with a management plan for Area II, more thorough knowledge is needed about the actual market for fuelwood. If, indeed, most of the city's demand is satisfied by the residents themselves, then a different approach targeting those residents without a "personal" fuelwood supply will be required. At the same time the Forest Service will also need to work with landholders to help them manage their individual supplies.

78. Priority Area III. The third priority area is further away, but is accessible by the Tougan road, a route which is generally not in good repair. According to sources in Ouahigouya, FED funds are scheduled to improve this road substantially over the next five years. If this does occur, the increased accessibility will place this area higher on the priority list.

79. Growing stock on natural forest lands in this area is estimated to be about 23,000 tons on slightly less than 42,000 ha. Two-thirds of the area is classed as M in scattered blocks. This area was also less affected (than Areas I and IV) by the severe drought conditions during the last decade. Annual growth (productivity) of commercial fuelwood species on these natural forest areas could be as much as 8,500 tons per year. Unless access and market price improves, incentives for managing this area by the local population will not be great. The area, nevertheless, does have a large contiguous block of natural forest land that would benefit from management activities - particularly if conditions change. It is an area that needs to be monitored by Forest Service staff in Ouahigouya.

80. Priority Area IV. The area last on the priority list has furnished considerable quantities of fuelwood to the city since price restructuring occurred in 1985. The area is located northwest of the city in a band of forest near the Malian border. Although the terrain is flat and uniform the existing road conditions severely limit access. Many of the standing trees, like those in Area I, are dead, having succumbed to the 1983-84 drought. It merits the priority list, however, because of the large area of uninhabited woodlands. Decision makers should be aware that there is a considerable fuelwood resource located there. As in Area I, this are has also been too radically affected by the drought to allow a meaningful estimate of the standing volume. Annual production, however, has been estimated at about 11,400 tons on the 56,000 ha of natural forest lands.

81. The annual production potential from all the priority areas indicates that there is enough fuelwood to satisfy the city's demands through the year 2000. Management of these areas won't occur, however, unless there are substantially more incentives for producers and suppliers in the region. Until that occurs Forest Service personnel will need to concentrate their efforts on improving the management of the wooded fallow areas surrounding the city.

82. Because of the intensity of agriculture, the low rainfall, and fragile soils, a long-term agroforestry development strategy should be considered. Trees grown on farm lands can support agriculture through their positive soil and water conservation attributes. At the same time, the trees can produce wood for family use and for occasional sale.

Table A10.1: Standing Fuelwood Estimates for Priority Areas within the Ouagadougou Fuelwood Supply Zone

Priority area	Class N			Class F			Class M			Total tons
	Ha*	M3+	Tons#	Ha*	M3+	Tons#	Ha*	M3+	Tons#	
Ia	2600	19500	15600	9200	45540	36432	0	0	0	52032
Ib	0	0	0	5600	27720	22176	0	0	0	22176
II	29700	222750	178200	24200	119790	95832	4600	11385	9108	283140
III	35500	266250	213000	7800	38610	30888	0	0	0	243888
IV	18600	139500	111600	0	0	0	0	0	0	111600
V	17600	132000	105600	126400	625680	500544	75800	187605	150084	756228
VI	290400	2178000	1742400	136900	677655	542124	29600	73260	58608	2343132
Totals	394400	2958000	2366400	310100	1534995	1227996	110000	272250	217800	3812196

* Area estimates from forest cover map
\+ Based on : 12,5 m^3/ha or 50% of the average standing volume reported for the natural forests in the Center-East, Center, and Center-West Departments (Cameratti 1983)
\# Assumes: 0,8 tons/m^3 (DeBaker 1982)

Additional assumptions associated with using Grosenick and Hagen's (1988b) cover classes:

Class N contains 100% of the estimated volume
Class F contains 66% of the estimated volume
Class M contains 33% of the estimated volume

Only 60% of the standing volume in each class is commercial fuelwood of usable diameter.

SAMPLE CALCULATION: Standing volume estimated for Priority Area II, Class F

Area		average standing volume	x	cover class adjustment	x	% of commercial fuelwood	=	Estimated volume
24.200 ha	x	12,5m^3	x	66%	x	60%	=	119.790 m^3

Table A10.2: Estimated Annual Productivity of Priority Areas within the Ouagadougou Fuelwood Supply Zone

Priority area	Class N			Class F			Class M			Total tons
	Ha*	M3+	Tons#	Ha*	M3+	Tons#	Ha*	M3+	Tons#	
Ia	2600	1373	1098	9200	4858	3886	0	0	0	4984
Ib	0	0	0	5600	2957	2365	0	0	0	2365
II	29700	15682	12545	24200	12778	10222	4600	2429	1943	24710
III	35500	23572	18858	7800	5179	4143	0	0	0	23001
IV	18600	12350	9880	0	0	0	0	0	0	9880
V	17600	11686	9349	126400	83930	6[illegible]144	75800	50331	40265	116758
VI	290400	192826	154260	136900	90902	72721	29600	19654	15724	242705
Totals	394400	257489	205991	310100	200602	160482	110000	72414	57932	424404

* Area estimates from forest cover maps
\+ Volumes calculated using average growth estimates from Clement (1982)

Average growth for Priority Areas Ia, Ib, II = 0.66 m^3/ha/year (average annual rainfall = 750 mm)
Average growth for Priority Areas III, IV, V, VI = 0.83 m^3/ha/year (average annual rainfall = 850 mm)

\# Assumes: 0.8 tons/m^3 (DeBaker 1982)

Additional assumptions:

80% of the growth is in commercial fuelwood species (Gosenick and Hagen 1988b)
Rural Fuelwood demand is satisfied from other sources.

SAMPLE CALCULATION: Estimated volume in annual growth for Priority Area II, Class F

area	x	growth estimate (all species)	x	% in commercial fuelwood	x	Total volume	or	weight equivalent
24.200 ha	x	0.66 m^3/ha/year	x	80%	x	12.778 m^3	=	10.22[illegible] tons

Table A10.3: Standing Fuelwood Estimates for Priority Areas within the Koudougou Fuelwood Supply Zone

Priority area	Class N			Class F			Class M			Total in tons
	Ha*	M3+	Tons#	Ha*	M3+	Tons#	Ha*	M3+	Tons#	
I	18800	141000	112800	6600	32670	26136	1500	3713	2970	141906
II	7700	57750	46200	4000	19800	15840	8400	20790	16632	78672
III	0	0	0	0	0	0	24100	59648	47718	47718
Subtotal	26500	198750	159000	10600	52470	41976	34000	84150	67320	268296
Ouaga zones										
IV	18600	139500	111600	0	0	0	0	0	0	111600
V	17600	132000	105600	126400	625680	500544	75800	187605	150084	756228
Totals	62700	470250	376200	137000	678150	542520	109800	271755	217404	1136124

* Area estimates from forest cover maps
\+ Based on: 12.5 m^3/ha or 50% of the average standing volume reported for the natural forests in the Center-East, Center, and Center-West Departments (Cameratti 1983)
\# Assumes: 0.8 tons/m^3 (DeBaker 1982)

Additional assumptions associated with using Grosenick and Hagen's (1988b) cover classes:

Class N contains 100% of the estimated volume
Class F contains 66% of the estimated volume
Class M contains 33% of the estimated volume

Only 60% of the standing volume in each class is commercial fuelwood of usable diameter.

SAMPLE CALCULATION: Standing volume estimated for Priority Area III, Class M

area	x	average standing volume	x	cover class adjustment	x	% of commercial fuelwood	=	estimated volume
24.100 ha	x	12,5m^3	x	33%	x	60%	=	59.648 m^3

Table A10.4: Estimated Annual Productivity Areas within the Koudougou Supply Zone

Priority area	Class N			Class F			Class M			Total tons
	Ha*	M3+	Tons#	Ha*	M3+	Tons#	Ha*	M3+	Tons#	
I	18800	12483	9987	6600	4382	3506	1500	996	797	14289
II	7700	5113	4090	4000	2656	2125	8400	5578	4462	10677
III	0	0	0	0	0	0	24100	14315	11452	11452
Subtotals	26500	17596	14077	10600	7038	5631	34000	20889	16711	36419
Ouaga zones										
IV	18600	12350	9880	0	0	0	0	0	0	9880
V	17600	11686	9349	126400	83930	67144	75800	50331	40265	116758
Totals	62700	41633	33306	137000	90968	72774	109800	71220	56976	163057

* Area estimates from forest cover maps
+ Volumes calculated using average growth estimates from Clement (1982)

Average growth for Priority Areas III = 0.66 m^3/ha/year (average annual rainfall = 750 mm)
Average growth for Priority Areas I, II, IV, V = 0.83 m^3/ha/year (average annual rainfall = 850 mm)

\# Assumes: 0.8 tons/m^3 (DeBaker 1982)

Additional assumptions:

80% of the growth in Areas I, II, IV, V, and
90% of the growth in Area III is in commercial fuelwood species (Grosenick & Hagen 1988b)
Rural fuelwood demand is satisfied from other sources.

SAMPLE CALCULATION: Estimated volume in annual growth for Piority Area III, Class M

area	x	growth estimate (all species)	x	% in commercial fuelwood	x	total volume	or weight equivalent
24.100 ha	x	0.66 m^3/ha/year	x	90%	x	14.315 m^3	= 11.452 tons

Table A10.5: Standing Fuelwood Estimates for Priority Areas within the Bobo-Dioulasso Fuelwood Supply Zone

Priority area	Class N			Class F			Class M			Total tons
	Ha*	M3+	Tons#	Ha*	M3+	Tons#	Ha*	M3+	Tons#	
I	4400	36960	29568	0	0	0	0	0	0	29568
II	0	0	0	1800	9979	7983	0	0	0	7983
III	0	0	0	9700	53777	43021	33000	91476	73181	116202
IV	7700	64680	51744	3000	16632	13306	0	0	0	65050
V	23000	193200	154560	62400	345946	276756	5000	13860	11088	442404
Totals	35100	294840	235872	76900	426334	341067	38000	105336	84269	661208

* Area estimates from forest cover maps
+ Based on: 14 m^3/ha or 50% of the average standing volume reported for the natural forests in the Haut-Bassin Department (Cameratti 1983)

\# Assumes: 0.8 tons/m^3 (DeBaker 1982)

Additional assumptions associated with using Grosenick and Hagen's (1988b) cover classes:

Class N contains 100% of estimated volume
Class F contains 66% of estimated volume
Class M contains 33% of estimated volume

Only 60% of the standing volume in each class is commercial fuelwood of usable diameter.

SAMPLE CALCULATION: Standing volume estimated for Priority Area I, Class N

Area		average standing volume	x	cover class adjustment	x	% of commercial fuelwood	=	estimated volume
4.400 ha	x	14 m^3	x	100%	x	60%	=	36.960 m^3

Table A10.6: Estimated Annual Productivity Areas within the Bobo-Dioulasso Fuelwood Supply Zone

Priority area	Class N			Class F			Class M			Total tons
	Ha*	M3+	Tons#	Ha*	M3+	Tons#	Ha*	M3+	Tons#	
I	4400	4787	3830	0	0	0	0	0	0	3830
II	0	0	0	1800	1958	1567	0	0	0	1567
III	0	0	0	9700	10554	8443	33000	35904	28723	37166
IV	7700	8378	6702	3000	3264	2611	0	0	0	9313
V	23000	25024	20019	62400	67891	54313	5000	5440	4352	78684
Totals	35100	38189	30551	76900	83667	66934	38000	41344	33075	130560

* Area estimates form forest cover maps
\+ Volumes calculated using average growth estimates from Clement (1982)

Average growth for Priority Areas I, II, III, IV, V = 1.36 m^3/ha/year (average annual rainfall = 1100 mm)

\# Assumes: 0.8 tons/m^3 (DeBaker 1982)

Additional assumptions:

80% of the growth is in commercial fuelwood species (Grosenick & Hagen 1988b)
Rural fuelwood demand is satisfied from other sources.

SAMPLE CALCULATION: Estimated volume in annual growth for Priority Area I, Class N

Area	growth estimate (all species)	x	% in commercial fuelwood	x	total volume	or weight equivalent
4.400 ha	x 1.36 m^3/ha/year	x	80%	x	4.787 m^3	= 3.830 tons

Table A10.7: Standing Fuelwood Estimates for Priority Areas within the Ouahigouya Fuelwood Supply Zone

Priority area	Class N			Class F			Class M			Total tons
	Ha*	M3+	Tons#	Ha*	M3+	Tons#	Ha*	M3+	Tons#	
I**	1600	2438	1951	9400	9455	7564	36900	18558	14846	24361
II	0	0	0	9000	9053	7242	29900	15037	12030	19272
III	0	0	0	15200	15289	12231	26600	13378	10702	22933
IV**	26900	40996	32796	12100	12171	9737	16700	8399	6719	49252
Totals	28500	43434	34747	45700	45967	36774	110100	55371	44297	115818

* Area estimates from forest cover maps.
+ Based on: 2,54 m³/ha or 50% of the average standing volume reported for shrub savannah lands (Cameratti 1983)

\# Assumes: 0,8 tons/m³ (DeBaker 1982)

** Figures presented are highly speculative given the large amounts of drought-killed trees in this area.

Additional assumptions associated with using Grosenick and Hagen's (1988b) cover classes:

Class N contains 100% of the estimated volume
Class F contains 66% of the estimated volume
Class M contains 33% of the estimated volume

Only 60% of the standing volume in each class is commercial fuelwood of usable diameter.

SAMPLE CALCULATION: Standing volume estimated for Priority Area IV, Class F

area	x	average standing volume	x	cover class adjustment	x	% of commercial fuelwood	=	estimated volume
12.100 ha	x	2,54 m³	x	66%	x	60%	=	12.171 m³

Table A10.8: Estimated Annual Productivity Areas within the Ouahigouya Fuelwood Supply Zone

Priority area	Class N			Class F			Class M			Total tons
	Ha*	M3+	Tons#	Ha*	M3+	Tons#	Ha*	M3+	Tons#	
I	1600	410	328	9400	2406	1925	36900	9446	7557	9810
II	0	0	0	9000	2304	1843	29900	7654	6124	7967
III	0	0	0	15200	3891	3113	26600	6810	5448	8561
IV	26900	6886	5509	12100	3098	2478	16700	4275	3420	11407
Totals	28500	7296	5837	45700	11699	9359	110100	28186	22548	37745

* Area estimates from forest cover maps
+ Volumes calculated using average growth estimates from Clement (1982)

Average growth for Priority Areas I, II, III, IV = 0.32 m^3/ha/year (average annual rainfall = 500 mm)

\# Assumes: 0.8 tons/m^3 (DeBaker 1982)

Additional assumptions:

80% of the growth is in commercial fuelwood species (Grosenick & Hagen 1988b)
Rural fuelwood demand is satisfied from other sources.

SAMPLE CALCULATION: Estimated volume in annual growth for Priority Area IV, Class F

area		Growth estimate (all species)	x	% in commercial fuelwood	x	total volume		or weight equivalent
12.100 ha	x	0.32 m^3/ha/year	x	80%	x	3.098 m^3	=	2.478 tons

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO:
COUNTRY: BURKINA FASO

OUAGADOUGOU
Priority area Ia, Ib

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time Period
15 years

Total forest area	61.200 ha
No. compartments	15
Average compartment	4080,00 ha

Forest cover classes represented

Class	Stocking	Total Area	Avg. cpt area
N:	100%	2.600 ha	173,3 ha
F:	66%	14.800	986,7
M:	33%	0	0,0
Sub-totals:		17.400	1.160,0
J, J-C:	25%	39.700	2.646,7
P:	100%	4.100	273,3

Average standing volume
12,5 m^3/ha

Productivity (m^3/ha/an)

High	Medium	Low
1,0	0,66	0,5

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere total official retail price in Ouagadougou

Productivity assumed
0,66 m^3/ha/year

Physical Outputs

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	1083	1141	1198	1255	1312	1369	1427	1484	1541	1598	1655	1713	1770	1827	1884
F Class lands	m^3	4070	4396	4721	5047	5372	5698	6024	6349	6675	7000	7326	7652	7779	8303	8628
M Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	m^3	5153	5536	5919	6302	6685	7067	7450	7833	8216	8599	8981	9364	9747	10130	10513
J, J-C lands	m^3	4135	5009	5882	6756	7629	8502	9376	10249	11123	11996	12869	13743	14616	15490	16363
Plantations (P)	m^3	1708	1799	1889	1979	2069	2159	2250	2340	2430	2520	2610	2701	2791	2881	2971
Total fuelwood	m^3	10997	12343	13690	15036	16383	17729	19075	20422	21768	23115	24461	25807	27154	28500	29847
	steres	35191	39499	43808	48116	52425	56733	61042	65350	69659	73679	78275	82584	86892	91201	95509
	tons	8798	9875	10952	12029	13106	14183	15260	16338	17415	18492	19569	20646	21723	22800	23877

15 yr volume cut	steres	980250
Average removed/ha	steres	16,0

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO:
COUNTRY: BURKINA FASO

OUAGADOUGOU
Priority area II

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time period
15 years

Total forest area	58.500 ha
No compartments	15
Average compartment	3900,00 ha

Forest cover classes represented

Class	Stocking	Total area	Average compartments area	Average standing volume 12,5 m^3/ha
N:	100%	29.700 ha	1980,0 ha	
F:	66%	24.200	1613,3	Productivity (m^3/ha/year)
M:	33%	4.600	306,7	High Medium Low
Subtotal:		58.500	3.900,0	1,0 0,66 0,5
J, J-C:	25%	0	0,0	
P:	100%	0	0,0	

Miscellaneous assumptions:

	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere official retail price in Ouagadougou

Productivity assumed
0,66 m^3/ha/year

Physical Outputs

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	12375	13028	13682	14335	14989	15642	16295	16949	17602	18256	18909	19562	20216	20869	21523
F Class lands	m^3	6655	7187	7720	8252	8785	9317	9849	10382	10914	11447	11979	12511	13044	13576	14109
M Class lands	m^3	633	734	835	936	1037	1139	1240	1341	1442	1543	1645	1746	1847	1948	2049
Subtotals	m^3	19663	20950	22237	23524	24811	26098	27385	28672	29959	31246	32533	33820	3507	36394	37681
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	19663	20950	22237	23524	24811	26098	27385	28672	29959	31246	32533	33820	35107	36394	37681
	steres	62920	67038	71157	75275	79394	83512	87630	91749	95867	99986	104104	108222	112341	116459	120578
	tons	15730	16760	17789	18818	19848	20878	21908	22937	23967	24996	26026	27056	28085	29115	30144

15 year volume cut	steres	1376232
Average removed/ha	steres	23,5

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO:
COUNTRY: BURKINA FASO

OUAGADOUGOU
Priority area III

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time Period
15 years

Total forest area	55.400 ha
No. compartments	15
Average compartment	3693,33 ha

Forest cover classes represented

Class	Stocking	Total area	Average area/ compartments	Average standing volume 12,5 m^3/ha
N:	100%	35.500 ha	2.366,7 ha	
F:	66%	7.800	520,0	Productivity (m^3/ha/year)
M:	33%	0	0,0	High Medium Low
Subtotals:		43.300	2.886,7	1,0 0,83 0,5
J, J-C:	25%	12.100	806,7	
P:	100%	0	0,0	

Miscellaneous assumptions:

	Equal distributions of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Physical Outputs

Assumed productivity 0,83 m^3/ha/year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units, commercial fuelwood removed																
N Class lands	m^3	14792	15774	16756	17738	18720	19703	20685	21667	22649	23631	24613	25596	26578	27560	28542
F Class lands	m^3	2145	2361	2577	2792	3008	3224	3440	3656	3871	4087	4303	4519	4735	4950	5166
M Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotals	m^3	16937	18135	19333	20531	21729	22927	24124	25322	26520	27718	28916	30114	31312	32510	33708
J, J-C lands	m^3	1260	1595	1930	2265	2599	2934	3269	3604	3939	4273	4608	4943	5278	5612	5947
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	18197	19730	21263	22795	24328	25861	27393	28926	30459	31992	33524	35057	36590	38123	39655
	steres	58231	63135	68040	72945	77850	82754	87659	92564	97469	102373	107278	112183	117088	121992	126837
	tons	14558	15784	17010	18236	19462	20689	21915	23141	24367	25593	26820	28046	29272	30498	31724

15 year volume cut	steres	1388458
Average removed/ha	steres	25,1

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: OUAGADOUGOU
COUNTRY: BURKINA FASO — Priority area IV

TECHNICAL AND BIOLOGICAL ASSUMPTIONS — Time period 15 years

Total forest area	18.600 ha
No. compartments	15
Average compartment	1240,00 ha

Forest cover classes represented

Class	Stocking	Total Area	Average area/ compartments	Average standing volume 12,5 m^3/ha
N:	100%	18.600 ha	1.240,0 ha	
F:	66%	0	0,0	Productivity (m^3/ha/year)
M:	33%	0	0,0	High Medium Low
Subtotals:		0	1.240,0	1,0 0,66 0,5
J, J-C:	25%	0	0,0	
P:	100%	0	0,0	

Miscellaneous assumptions:

	Equal distributions of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Physical Outputs

Productivity assumed 0,66 m^3/ha/year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units commercial fuelwood removed																
N Class lands	m^3	7750	8159	8568	8978	9387	9796	10205	10614	11024	11433	11842	12251	12660	13070	13479
F Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotals	m^3	7750	8159	8568	8978	9387	9796	10205	10614	11024	11433	11842	12251	12660	13070	13479
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	7750	8159	8568	8978	9387	9796	10205	10614	11024	11433	11842	12251	12660	13070	13479
	steres	24800	26109	27419	28728	30038	31347	32657	33966	35276	36585	37894	39204	40513	41823	43132
	tons	6200	6527	6855	7182	7509	7837	8164	8492	8819	9146	9474	9801	10128	10456	10783

15 year volume cut	steres	509491
Average removed/ha	steres	27,4

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: OUAGADOUGOU
COUNTRY: BURKINA FASO — Priority area V

TECHNICAL AND BIOLOGICAL ASSUMPTIONS — Time period 15 years

Total forest area	221.200 ha
No. compartments	15
Average compartment	14746,67 ha

Forest cover classes represented

Class	Stocking	Total Area	Average area compartments	Average standing volume 12,5 m^3/ha	
N:	100%	17.600 ha	1.173,3 ha		
F:	66%	126.400	8.426,7	Productivity (m^3/ha/year)	
M:	33%	75.800	5.053,3	High	Medium Low
Subtotals:		219.800	14.653,3 1,0	0,83	0,5
J, J-C:	25%	1.400	93,3		
P:	100%	0	0,0		

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed 0,83 m^3/ha/year — Physical Outputs

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	7333	7820	8307	8794	9281	9768	10255	10742	11229	11716	12203	12690	13177	13663	14150
F Class lands	m^3	34760	38257	41754	45251	48748	52245	55742	59239	62737	66234	69731	73228	76725	80222	83719
M Class lands	m^3	10423	12520	14617	16714	18811	20908	23005	25102	27200	29297	31394	33491	35588	37685	39782
Subtotals	m^3	52516	58597	64678	70759	76840	82922	89003	95084	101165	107246	113327	119408	125489	131571	137652
J, J-C lands	m^3	146	185	223	262	301	340	378	417	456	494	533	572	611	649	688
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	52662	58782	64901	71021	77141	83261	89381	95501	101621	107740	113860	119980	126100	132220	138340
	steres	168517	188101	207694	227268	246852	266435	286019	305602	325186	344769	364353	383937	403520	423104	442687
	tons	42129	47025	51921	56817	61713	66609	71505	76401	81296	86192	91088	95984	100880	105776	110672

15 year volume cut	steres	4584035
Average removed/ha	steres	20,7

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO:
COUNTRY: BURKINA FASO

OUAGADOUGOU
Priority area VI

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time period
15 years

Total forest area	456.900 ha
No. compartments	15
Average compartment	30460,00 ha

Forest cover classes represented

Class	Stocking	Total Area	Average compartment area		Average standing volume 12,5 m^3/ha	
N:	100%	290.400 ha	19.360,0 ha			
F:	66%	136.900	9.126,7		Productivity (m^3/ha/year)	
M:	33%	29.600	1.973,3		High	Medium Low
Subtotals:		456.900	30.460,0	1,0	0,83	0,5
J, J-C:	25%	0	0,0			
P:	100%	0	0,0			

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price fo fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed 0,83 m^3/ha/year		Physical Outputs 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	121000	129034	137069	145103	153138	161172	169206	177241	185275	193310	201344	209378	217413	225447	233482
F Class lands	m^3	37648	41435	45223	49010	52798	56585	60373	64160	67948	71736	75523	79311	83098	86886	90673
M Class lands	m^3	4070	4863	5708	6527	7346	8165	8984	9803	10621	11440	12259	13078	13897	14716	15535
Subtotals	m^3	162718	175358	187999	200640	213281	225922	238563	251204	263845	276486	289127	301767	314408	327049	339690
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	162718	175358	187999	200640	213261	225922	238563	251204	263845	276486	289127	301767	314408	327049	339690
	steres	520696	561147	601598	642049	682500	722950	763401	803852	844303	884754	925205	965656	******	******	******
	tons	130174	140287	150399	160512	170625	180738	190850	200963	211076	221188	231301	241414	251527	261639	271752

15-year volume cut	steres	12057782
Average removed/ha	steres	26.4

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: BOBO-DIOULASSO
COUNTRY: BURKINA FASO Priority area I

RECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time period
15 years

Total forest area	6.000 ha
No. compartiments	15
Average compartment	400,00 ha

Forest cover classes represented

Class	Stocking	Total area	Average compartments area	Average standing volume 14,0 m^3/ha
N:	100%	4.400 ha	293,3 ha	
F:	66%	0	0,0	Productivity (m^3/ha/year)
M:	33%	0	0,0	High Medium Low
Subtotals:		4.400	293,3	1,0 0,83 0,5
J, J-C:	25%	0	0,0	
P:	100%	1.600	106,7	

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed 1,36 m^3/ha/year		Physical Outputs 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	2053	2253	2452	2652	2851	3051	3250	3450	3649	3849	4048	4247	4447	4646	4846
F Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotals	m^3	2053	2253	2452	2652	2851	3051	3250	3450	3649	3849	4048	4247	4447	4646	4846
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	747	819	892	964	1037	1109	1182	1254	1327	1399	1472	1545	1617	1690	1762
Total fuelwood	m^3	2800	3072	3344	3616	3888	4160	4432	4704	4976	5248	5520	5792	6064	6336	6608
	steres	8960	9830	10701	11571	12442	13312	14182	15053	15923	16794	17664	18534	19405	20275	21146
	tons	2240	2458	2675	2893	3110	3328	3546	3763	3981	4198	4416	4634	4851	5069	5286
15 year volume cut	steres	225792														
Average removed/ha	steres	37,6														

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO:
COUNTRY: BURKINA FASO

BOBO-DIOULASSO
Priority area II

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time Period
15 years

Total forest area		1.800 ha
No. compartments	15	
Average compartment		120,00 ha

Forest cover classes represented

Class	Stocking	Total Area	Average Compartment area	Average standing volume 14,0 m^3/ha		
N:	100%	0 ha	0,0 ha			
F:	66%	1.800	120,0	Productivity (m^3/ha/year)		
M:	33%	0	0,0	High	Medium	Low
Subtotals:		1.800	120,0	1,0	1,36	0,5
J, J-C:	25%	0	0,0			
P:	100%	0	0,0			

Miscellaneous assumptions:

Equal distribution of all cover classes in each compartment
One compartment is harvested per year
50% of the standing volume is removed during each commercial fuelwood cut
3,2 steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed 1,36 m^3/ha/year		Physical Output 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F Class lands	m^3	554	636	718	799	881	962	1044	1126	1207	1289	1370	1452	1534	1615	1697
M Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotals	m^3	554	636	718	799	881	962	1044	1126	1207	1289	1370	1452	1534	1615	1697
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	554	636	718	799	881	962	1044	1126	1207	1289	1370	1452	1534	1615	1697
	steres	1774	2035	2296	2557	2819	3080	3341	3602	3863	4124	4385	4646	4908	5169	5430
	tons	444	509	574	639	705	770	835	900	966	1031	1096	1162	1227	1292	1357

15 year volume cut	steres	54028,8
Average removed/ha	steres	30,0

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: BOBO-DIOULASSO
COUNTRY: BURKINA FASO Priotiry area III

TECHNICAL AND BIOLOGICAL ASSUMPTIONS: Time period 15 years

Total forest area	53.300 ha
No. compartments	15
Average compartment	3553,33 ha

Forest cover classes represented

Class	Stocking	Total Area	Average Compartment area	Average standing volume 14,0 m^3/ha
N:	100%	0 ha	0,0 ha	
F:	66%	9.700	646,7	Productivity (m^3/ha/year)
M:	33%	33.000	2.200,0	High Medium Low
Subtotals:		42.700	2.846,7	1,0 1,36 0,5
J, J-C:	25%	10 600	706,7	
P:	100%	0	0,0	

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Physical Outputs

Productivity assumed 1,36 m^3/ha/year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F Class lands	m^3	2988	3427	3867	4307	4747	5186	5626	6066	6505	6945	7395	7825	8264	8704	9144
M Class lands	m^3	5082	6578	8074	9570	11066	12562	14058	15554	17050	18546	20042	21538	23034	24530	26026
Subtotals	m^3	8070	10005	11941	13877	15813	17748	19684	21620	23555	25491	27427	29363	31298	33234	35170
J, J-C lands	m^3	1237	1717	2198	2678	3159	3639	4120	4600	5081	5561	6042	6523	7003	7484	7964
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	9306	11723	14139	16555	18971	21388	23804	26220	28636	31053	33469	35885	38301	40718	43134
	steres	29780	37512	45244	52976	60708	68440	76172	83904	91636	99369	107101	114833	122565	130297	138029
	tons	7445	9378	11311	13244	15177	17110	19043	20976	22909	24842	26775	28708	30641	32574	34507

15 year volume cut	steres	1258566
Average removed/ha	steres	23,6

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: BOBO-DIOULASSO
COUNTRY: BURKINA FASO Priority area IV

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time period
15 years

Total forest area		10.700 ha
No. compartments	15	
Average compartment		713,33 ha

Forest cover classes represented

Class	Stocking	Total Area	Average compartment area	Average standing volume 14,0 m^3/ha		
N:	100%	7.700 ha	513,3 ha			
F:	66%	3.000	200,0	Productivity (m^3/ha/year)		
M:	33%	0	0,0	High	Medium	Low
Subtotals:		10.700	713,3	1,0	1,36	0,5
J, J-C :	25%	0	0,0			
P:	100%	0	0,0			

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed
1,36 m^3/ha/year

Physical Outputs

Units Commercial fuelwood removed		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
N Class lands	m^3	3593	3942	4291	4641	4990	5339	5688	6037	6386	6735	7084	7433	7782	8131	9480
F Class lands	m^3	924	1060	1196	1332	1468	1604	1740	1876	2012	2148	2284	2420	2556	2692	2828
M Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotals	m^3	4517	5002	5487	5973	6458	6943	7428	7913	8398	8883	9368	9853	10338	10823	11308
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	4517	5002	5487	5973	6458	6943	7428	7913	8398	8883	9368	9853	10338	10823	11308
	steres	14455	16008	17560	19112	20664	22217	23769	25321	26873	28425	29978	31530	33082	34634	36186
	tons	3614	4002	4390	4778	5166	5554	5942	6330	6718	7106	7494	7882	8271	8659	9047

15 year volume cut	steres	379814
Average removed/ha	steres	35,5

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: BOBO-DIOULASSO
COUNTRY: BURKINA FASO Priority area V

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time period
15 year

Total forest area:	90.400 ha
No. compartments	15
Average compartment	6027,67 ha

Forest cover classes represented

Class	Stocking	Total Area	Average Compartment Area
N:	100%	23.000 ha	1.533,3 ha
F:	66%	62.400	4.160,0
M:	33%	5.000	333,3
Subtotal:		90.400	6.026,7
J, J-C:	25%	0	0,0
P:	100%	0	0,0

Average standing volume
14,0 m^3/ha

Productivity (m^3/ha/year)

High	Medium	Low
1,0	1,36	0,5

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed
1,36 m^3/ha/year — Physical Outputs

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
Class N lands	m^3	10733	11776	12819	13861	14904	15947	16989	18032	19075	20117	21160	22203	23245	24288	25331
Class F lands	m^3	19219	22048	24877	27706	30534	33363	36192	39021	41850	44678	47507	50336	53165	55994	58822
Class M lands	m^3	770	997	1223	1450	1677	1903	2130	2357	2583	2810	3037	3263	3490	3717	3943
Subtotals	m^3	30723	34821	38919	43017	47115	51213	55311	59409	63508	67606	71704	75802	79900	83998	88096
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	30723	34821	38919	43017	47115	51213	55311	59409	63508	67606	71704	75802	79900	83998	88096
	steres	98312	111426	124540	137654	150768	163882	176996	190110	203224	216338	229452	242566	255680	268794	281908
	tons	24578	27857	31135	34414	37692	40971	44249	47528	50806	54085	57363	60642	63920	67199	70477

15 year volume cut	steres	2851654
Average removed/ha	steres	31,5

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: OUAHIGOUYA
COUNTRY: BURKINA FASO — Priority area I

TECHNICAL AND BIOLOGICAL ASSUMPTIONS — Time period 15 years

Total forest area	47.900 ha
No. compartments	15
Average compartment	3193,33 ha

Forest cover classes represented

Class	Stocking	Total Area	Average Compartment Area	Average standing volume 2,5 m^3/ha
N:	100%	1.600 ha	106,7 ha	
F:	66%	9.400	626,7	Productivity (m^3/ha/year)
M:	33%	36.900	2.460,0	High Medium Low
Subtotals:		47.900	3.193,3	1,0 0,32 0,5
J, J-C:	25%	0	0,0	
P:	100%	0	0,0	

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Physical Outputs

Productivity assumed 0,32 m^3/ha/year		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units commercial fuelwood removed																
N Class lands	m^3	135	153	170	187	204	221	238	255	272	289	306	323	340	357	374
F Class lands	m^3	525	626	726	826	926	1027	1127	1227	1327	1428	1528	1628	1728	1829	1929
M Class lands	m^3	1031	1425	1818	2212	2605	2999	3393	3786	4180	4573	4967	5361	5754	6148	6541
Subtotals	m^3	1692	2203	2714	3225	3735	4246	4757	5268	5779	6290	6801	7312	7823	8334	8845
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	1692	2203	2714	3225	3735	4246	4757	5268	5779	6290	6801	7312	7823	8334	8845
	steres	5414	7049	8683	10318	11953	13588	15223	16858	18493	20128	21763	23398	25033	26668	28303
	tons	1353	1762	2172	2580	2988	3397	3806	4215	4623	5032	5441	5850	6258	6667	7076

15-year volume cut	steres	252876
Average removed/ha	steres	5,3

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO:
COUNTRY: BURKINA FASO

OUAHIGOUYA
Priority area II

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time period
15 years

Total forest area	38.900 ha
No. compartments	15
Average compartment	2593,33 ha

Forest cover classes represented

Class	Stocking	Total area	Average Compartment area	Average standing volume 2,5 m^3/ha		
N:	100%	0 ha	0,0 ha			
F:	66%	9.000	600,0	Productivity (m^3/ha/year)		
M:	33%	29.900	1.993,3	High	Medium	Low
Subtotals:		38.900	2.593,3	1,0	0,32	0,5
J, J-C:	25%	0	0,0			
P:	100%	0	0,0			

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested par year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed 0,32 m^3/ha/year		Physical Outputs 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F Class lands	m^3	503	599	695	791	887	983	1079	1175	1271	1367	1463	1559	1655	1751	1847
M Class lands	m^3	835	1154	1473	1792	2111	2430	2749	3068	3387	3706	4025	4344	4663	4982	5300
Subtotals	m^3	1338	1753	2168	2583	2998	3413	3828	4243	4658	5073	5488	5903	6318	6732	7147
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	1338	1753	2168	2583	2998	3413	3828	4243	4658	5073	5488	5903	6318	6732	7147
	steres	4283	5610	6938	8266	9594	10922	12249	13577	14905	16233	17561	18888	20216	21544	22872
	tons	1071	1403	1735	2067	2398	2730	3062	3394	3726	4058	4390	4722	5054	5386	5718
15 year volume cut	steres	203657														
Average removed/ha	steres	5,2														

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: OUAHIGOUYA
COUNTRY: BURKINA FASO — Priority area III

TECHNICAL AND BIOLOGICAL ASSUMPTIONS — Time period 15 years

Total fores area		41.800 ha
No. compartments	15	
Average compartment		2786,67 ha

Forest cover classes represented

Class	Stocking	Total Area	Average compartment area	Average standing volume 2,5 m^3/ha
N:	100%	0 ha	0,0 ha	
F:	66%	15.200	1.013,3	Productivity (m^3/ha/year)
M:	33%	26.600	1.773,3	High Medium Low
Subtotals:		41.800	2.786,7	1,0 0,32 0,5
J, J-C:	25%	0	0,0	
P:	100%	0	0,0	

Miscellaneous assumptions:

Equal distribution of all cover classes in each compartment
One compartment is harvested per year
50% of the standing volume is removed during each commercial fuelwood cut
3,2 steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610 CFAF/stere to woodcutters
500 CFAF/stere forest management fund
300 CFAF/stere for the fuelwood tax (permis de coupe)
200 CFAF/stere for the cooperative fund
1610 CFAF/stere total official producer price for fuelwood

4320 CFAF/stere, official retail price in Ouagadougou

Productivity assumed 0,32 m^3/ha/year		Physical Outputs 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F Class lands	m^3	849	1012	1174	1336	1498	1660	1822	1984	2146	2309	2471	2633	2795	2957	3119
M Class lands	m^3	743	1027	1311	1594	1878	2162	2446	2729	3013	3297	3581	3864	4148	4432	4715
Subtotals	m^3	1593	2038	2484	2930	3376	3822	4268	4714	5160	5605	6051	6497	6943	7389	7835
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	1593	2038	2484	2930	3376	3822	4268	4714	5160	5605	6051	6497	6943	7389	7835
	steres	5096	6523	7950	9377	10803	12230	13657	15084	16510	17937	19364	20791	22218	23644	25071
	tons	1274	1631	1987	2344	2701	3058	3414	3771	4128	4484	4841	5198	5554	5911	6268

15 year volume cut	steres	226255
Average removed/ha	steres	5,4

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: OUAHIGOUYA
COUNTRY: BURKINA FASO — Priority area IV

TECHNICAL AND BIOLOGICAL ASSUMPTIONS — Time period 15 years

Total forest area	55.700 ha
No. compartments	15
Average compartment	3713,33 ha

Forest cover classes represented

Class	Stocking	Total Area	Average compartment area
N:	100%	26.900 ha	1.793,3 ha
F:	66%	12.100	806,7
M:	33%	16.700	1.113,3
Subtotals:		55.700	3.713,3
J, J-C:	25%	0	0,0
P:	100%	0	0,0

Average standing volume 2,5 m^3/ha

Productivity (m^3/ha/year)

High	Medium	Low
1,0	0,32	0,5

Miscellaneous assumptions:

Equal distribution of all cover classes in each compartment
One compartment is harvested per year
50% of the standing volume is removed during each commercial fuelwood cut
3,2 steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to wood cutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperatvie fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed 0,32 m^3/ha/year — Physical Outputs

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	2278	2564	2851	3138	3425	3712	3999	4286	4573	4860	5147	5434	5721	6008	6295
F Class lands	m^3	676	805	934	1063	1192	1321	1451	1580	1709	1838	1967	2096	2225	2354	2483
M Class lands	m^3	467	645	823	1001	1179	1357	1535	1714	1892	2070	2248	2426	2604	2782	2960
Subtotals	m^3	3420	4014	4609	5203	5797	6391	6985	7579	8173	8767	9362	9956	10550	11144	11738
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	3420	4014	4609	5203	5797	6391	6985	7579	8173	8767	9362	9956	10550	11144	11738
	steres	10945	12846	14747	16649	18550	20451	22352	24253	26155	28056	29957	31858	33760	35661	37562
	tons	2736	3212	3687	4162	4637	5113	5588	6063	6539	7014	7489	7965	8440	8915	9391

15 year volume cut	steres	363802
Average removed/ha	steres	6,5

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO:
COUNTRY: BURKINA FASO

KOUDOUGOU
Priority area I

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time period
15 years

Total forest area:	26.900 ha
No. compartments	15
Average compartment	1793,33 ha

Forest cover classes represented

Class	Stocking	Total Area	Average Compartment Area
N:	100%	18.800 ha	1.253,3 ha
F:	66%	6.600	440,0
M:	33%	1.500	100,0
Subtotals:		26.900	1.793,33
J, J-C:	25%	0	0,0
P:	100%	0	0,0

Average standing volume
12,5 m^3/ha

Productivity (m^3/ha/year)

High	Medium	Low
1,0	0,83	0,5

Miscellaneous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed 0,83 m^3/ha/year		Physical Outputs 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	7833	8353	8874	9394	9914	10434	10954	11474	11994	12515	13035	13555	14075	14595	15115
F Class lands	m^3	1815	1998	2180	2363	2545	2728	2911	3093	3276	3458	3641	3824	4006	4189	4371
M Class lands	m^3	206	248	289	331	372	414	455	497	538	580	621	663	704	746	787
Sub totals	m^3	9855	10599	11343	12087	12832	13576	14320	1064	15808	16553	17297	18041	18785	19530	20274
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	9855	10599	11343	12087	12832	13576	14320	1064	15808	16553	17297	18041	18785	19530	20274
	steres	31535	33916	36298	38679	41061	43442	45824	48205	50587	52969	55350	57732	60113	62495	64876
	tons	7884	8479	9074	9670	10265	10861	11456	12051	12647	13242	13838	14433	15028	15624	16219

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO:
COUNTRY: BURKINA FASO

KOUDOUGOU
Priority area II

TECHNICAL AND BIOLOGICAL ASSUMPTIONS

Time period
15 years

Total forest area	20.100 ha
No. compartments	15
Average compartment	1340,00 ha

Forest cover classes represented

Class	Stocking	Total Area	Average compartment area
N:	100%	7.700 ha	513,3 ha
F:	66%	4.000	266,7
M:	33%	8.400	560,0
Subtotals:		20.100	1.340,0
J, J-C:	25%	0	0,0
P:	100%	0	0,0

Average standing volume
12,5 m^3/ha

Productivity (m^3/ha/year)

High	Medium	Low
1,0	0,83	0,5

Miscellaneous assumptions:

Equal distribution of all cover classes in each compartment
One compartment is harvested per year
50% of the standing volume is removed during each commercial fuelwood cut
3,2 steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed
0,83 m^3/ha/year

Physical Outputs

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	3208	3421	3634	3847	4060	4274	4487	4700	4913	5126	5339	5552	5765	5978	6191
F Class lands	m^3	1100	1211	1321	1432	1543	1653	1764	1875	1985	2096	2207	2317	2428	2539	2649
M Class lands	m^3	1155	1387	1620	1852	2085	2317	2549	2782	3014	3247	3479	3711	3944	4176	4409
Subtotals	m^3	5463	6019	6576	7132	7688	8244	8800	9356	9912	10468	11024	11580	12137	12693	13249
J, J-C lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	5463	6019	6576	7132	7688	8244	8800	9356	9912	10468	11024	11580	12137	12693	13249
	steres	17483	19262	21042	22821	24601	26380	28160	29939	31719	33498	35278	37057	38837	40616	42396
	tons	4371	4816	5260	5705	6150	6595	7040	7485	7930	8375	8819	9264	9709	10154	10599

NATURAL FOREST MANAGEMENT OUTPUT SCENARIO: KOUDOUGOU
COUNTRY: BURKINA FASO — Piority area III

TECHNICAL AND BIOLOGICAL ASSUMPTIONS — Time period 15 years

Total forest area	51.600 ha
No. compartments	15
Average compartment	3440,00 ha

Forest cover classes represented

Class	Stocking	Total Area	Average Compartment Area	Average standing volume 12,5 m^3/ha		
N:	100%	0 ha	0,0 ha			
F:	66%	0	0,0	Productivity (m^3/ha/year)		
M:	33%	24.100	1.606,7	High	Medium	Low
Subtotals:		24.100	1.606,77	1,0	0,66	0,5
J, J-C:	25%	27.500	1.833,3			
P:	100%	0	0,0			

Miscellaneaous assumptions:

	Equal distribution of all cover classes in each compartment
	One compartment is harvested per year
50%	of the standing volume is removed during each commercial fuelwood cut
3,2	steres/1,0 m^3

REVENUE ASSUMPTIONS WITH OFFICIAL PRICES

610	CFAF/stere to woodcutters
500	CFAF/stere forest management fund
300	CFAF/stere for the fuelwood tax (permis de coupe)
200	CFAF/stere for the cooperative fund
1610	CFAF/stere total official producer price for fuelwood
4320	CFAF/stere, official retail price in Ouagadougou

Productivity assumed 0,66 m^3/ha/year — Physical Outputs

		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Units Commercial fuelwood removed																
N Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
F Class lands	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
M Class lands	m^3	3314	3844	4374	4904	5435	5965	6495	7025	7555	8086	8616	9146	9676	10206	10737
Subtotals	m^3	3314	3844	4374	4904	5435	5965	6495	7025	7555	8086	8616	9146	9676	10206	10737
J, J-C lands	m^3	2865	3470	4075	4680	5285	5890	6495	7100	7705	8310	8915	9520	10125	10730	11335
Plantations (P)	m^3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total fuelwood	m^3	6178	7314	8449	9584	10719	11854	12990	14125	15260	16395	17530	18666	19801	20936	22071
	steres	19771	23403	27036	30669	34301	37934	41567	45199	48832	52464	56097	59730	63362	66995	70628
	tons	4943	5851	6759	7667	8575	9483	10392	11300	12208	13116	14024	14932	15841	16749	17657

THE OUTLINE OF A BASIC MANAGEMENT PLAN

Basic Information
- Name of the Forest/Title of the Project
- Participants
- Plan Prepared by _____ ; Approved by _____
- Date
- Period covered by the Plan (operating years)

Background Information
- Location of the forest/map/topography
- Area, with compartment detail
- Past use
- Local conditions affecting the forest
- Intended utilization of outputs
- Background on participatory management agreement

Forest Situation
- Type(s) of forest with areas/percentages by type
- Stand history/condition
- Stocking information by compartment
- Growth and yield information (as available)

Actual Management
- Objectives of the management plan
- Restrictions and special circumstances
- Cutting methods/regulation
- Rotation/cuttin cycle
- Regeneration plan
- Protection plan
- Rehabilitation/restoration plan (if any)
- Grazing plan
- Secondary products management

Some major elements of a management plan.

THE ECONOMICS OF NATURAL FOREST MANAGEMENT

Average volume in m^3 per ha. = 12,5
Annual productivity in m^3 per ha. = 0,83
Rotation age 15 years
Total hectares = 15
Case I: Annual cut the first 15 years under management = 50%, from year 15 = 100%
Case II: Same as Case I, but with 100% clearance on each plot from year 1.

Annual Yields in m^3

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	12,5	13,33	14,16	14,99	15,82	16,65	17,48	18,31	19,14	19,97	20,8	21,63	22,46	23,29	24,12	12,45
Management	6,25	6,665	7,08	7,495	7,91	8,325	8,74	9,155	9,57	9,985	10,4	10,815	11,23	11,645	12,06	18,7
Unmanaged	187,5	0	0	0	0	0	0	0	0	0	124,5	0	0	0	0	0
Difference	-181,2	6,665	7,08	7,495	7,91	8,325	8,74	9,155	9,57	9,985	-114,1	10,815	11,23	11,645	12,06	18,7
Sumtotal		23770	Remaining forest cover:			87,15										
Difference 2	-175	13,33	14,16	14,99	15,82	16,65	17,48	18,31	19,14	19,97	-103,7	21,63	22,46	23,29	24,12	12,45
Sumtotal 2		6918.0	Remaining forest cover:			87,15										
Increase +20%	7,5	7,998	8,496	8,994	9,492	9,99	10,488	10,986	11,484	11,982	12,48	12,978	13,478	13,974	14,472	22,44
Decrease -20%	150	0	0	0	0	0	0	0	0	0	99,6	0	0	0	0	0
Difference	-142,5	7,998	8,496	8,994	9,492	9,99	10,488	10,986	11,484	11,982	-87,12	12,978	13,476	13,974	14,472	22,44

Year	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	
Management	19,115	19,53	19,945	20,36	20,775	21,19	21,605	22,02	22,435	22,85	23,265	23,68	24,095	24,51	28,45	
Unmanaged	0	0	0	0	124,5	0	0	0	0	0	0	0	0	0	124,5	
Difference	19,115	19,53	19,945	20,36	-103,7	21,19	21,605	22,02	22,435	22,85	23,265	23,68	24,095	24,51	-98,05	
Sumtotal																
Difference 2	12,45	12,45	12,45	12,45	-112,0	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	12,45	-112,0	
Sumtotal 2																
Increase +20%	22,938	23,436	23,934	24,432	24,93	25,428	25,926	26,424	26,922	27,42	27,918	28,416	28,914	29,412	31,74	
Decrease -20%	0	0	0	0	99,6	0	0	0	0	0	0	0	0	0	99,6	
Difference	22,938	23,436	23,934	24,432	-74,67	25,428	25,926	26,424	26,922	27,42	27,918	28,416	28,914	29,412	-67,86	87,15

Sumtotal 1499,7
IRR 0,0416

Including value of remaining forest cover:
IRR = 0,0614

N.B. This calculation of the economic value of natural forest management calculates only the volume impact of natural forest management over time. It takes neither the labour and material costs of forest management into account, nor the external benefits, e.g. continued access to medicinal plants an environmentally beneficial impacts into account.

PROJECT PROPOSALS: DETAILED DESCRIPTION

Urban Fuelwood Savings Project

1. **The problem:** Previous urban fuelwood savings programs have not taken adequate account of consumer needs and motivations for stove purchase and use and have, therefore, been an ineffective instrument to promote long-term woodfuel savings. They have also not considered the potential for energy savings amongst those segments of the population who continue to use traditional cooking methods.

2. These programs have paid insufficient attention to consumption of fuelwood and charcoal in the urban informal sector and the potential role this sector could play in advertising the advantages of energy saving equipment and behavior. It is estimated that they represent nearly 20% of total urban fuelwood consumption, a figure that can be expected to rise as the population grows. Activities such as food processing, and roadside restaurants are illustrative. There are, in addition, informal sector activities that could be expected to switch to modern fuels when provided the right incentives.

3. The informal sector beer brewers, who are largely women, are strong candidates for energy savings campaigns. They represent 12% of total urban fuelwood consumption and 60% of informal sector fuelwood consumption. While relatively few in number, these producers use significant amounts of fuelwood in their productive processes. To date, energy savings measures targeted at this group have been few, notwithstanding the existence on the market of a commercial stove, the **Burkido**, for beer production.

4. **Proposed approach:** The proposed project would include three components:

(a) Based on marketing studies, urban stove dissemination and energy savings campaigns would be designed for each of the four major urban centers, using contemporary advertising techniques and approaches. The campaigns would be tailored to the energy consumption patterns of each city and would have as their objectives to (a) increase stove sales; (b) reinforce energy savings by emphasizing the correct use and maintenance of fuelwood stoves; and (c) expand energy conservation by strengthening energy savings opportunities in traditional cooking practices. Monitoring mechanisms would be developed to assess performance of each campaign and an evaluation of the results would be carried out to assess the impact of these campaigns. Training would be provided to ensure the development of a monitoring capability over the longer term.

(b) A survey of the major biomass-consuming informal sector activities would be carried out to identify the most energy-intensive activities and actors, the nature and extent of their biomass consumption; prospects for inter-fuel substitution; incentives needed for more energy efficient productive processes and fuel switching; and other measures to increase productivity and income. A strategy and action program would

be defined and pilot operations funded. An in-country seminar would be held at the conclusion of the activity to present findings and preliminary conclusions from the pilot activities.

(c) A dissemination program to introduce the **dolotieres** to the **Burkido** in the urban centers would be designed and would include (i) a sales campaign; (ii) training in use and maintenance; (iii) a small line of credit to stimulate stove sales; (iv) identification of other measures to improve efficiency in beer production, (e.g. literacy training; basic bookkeeping; organization of cooperatives); and (v) development of monitoring mechanisms to ensure projected energy savings.

5. **Implementation arrangements:** The MET would be the implementing agency and would collaborate with NGOs working on stove programs. The Ministry of Commerce and IBE would be the implementing agencies responsible for the urban informal sector action program and **dolotieres'** improved stove activities and would collaborate with NGOs for implementation. National technical assistance and limited expatriate technical assistance (e.g. design of advertising campaigns) would be required including an advertising/media specialist; a sociologist; home economist; an economist; a training specialist; a small-scale enterprise specialist and a stove technologist.

Total estimated cost:	**US$ 1.5 million**
Implementation period:	**2 years**
Funding source:	**to be identified**

Institutions and Training Needs Assessment

6. **The problem:** An array of sectoral ministries and state agencies operate within the household energy and natural resource management sectors. The expansion of pilot activities executed under the Village Land Management Program into a full-scale national program and the preparation of a National Environment Action Plan will heighten the need for inter-agency coordination and cooperation.

7. **Proposed approach:** An analysis of the responsibilities and activities of the ministries and agencies in the household energy sector will be carried out, together with an evaluation of their capacity to execute their mandate in terms of manpower availability and skills and experience required to undertaken the expanded household energy program both for demand-side as well as supply-side activities. The extent to which in-country NGOs can assist in this process will also be evaluated. This analysis will be carried out using a participatory approach that will bring together staff from the concerned ministries and agencies and NGOs to identify the issues and develop appropriate solutions including requirements for short and long term training where appropriate.

8. **Implementation arrangements:** The Ministry of Plan will have overall responsibility for execution and will ensure coordination with the concerned ministries and agencies (Ministry of Environment and Tourism, Ministry of Agriculture, Ministry of Commerce, IBE, and others that may be identified the course of the study. Expatriate and local technical assistance will be required including 2 consultants experienced in the methodology of action-planning workshops; a household energy specialist; a forester; and a legal expert. This assessment will be executed within the organizational framework that will be established to execute the donor-assisted Natural Resources Management Project that was appraised in June 1990.

Total estimated cost:	**US$ 100,000**
Implementation period:	**12 months**
Funding source:	**to be identified**

LPG Infrastructure Strengthening Project

9. **The problem:** While LPG consumption in the household sector is currently restricted to a minority of the urban population, rapid population growth will see a rise in demand. To accommodate this demand, certain infrastructure investments will be required to expand handling capacity.

10. **Proposed approach:** Financing will be needed to: (a) expand storage capacity at the Bingo depot by two cigars (50 ton capacity each) (US$ 200,000); (b) bottle maintenance equipment and a manual painting installation (US$ 50,000); and (c) installation of a manual filling line for 3 and 6 kg (US$ 25,000) bottles with a capacity of 700 tons.

11. **Implementation arrangements:** SONABHY will be implementing agency and will tender the civil works.

Total estimated cost:	**US$ 275,000**
Implementation period:	**12 months**
Funding source:	**to be identified**

LPG Stove Development and Promotion Project

12. **The problem:** There are formidable psychological/cultural barriers to increased LPG use amongst households already possessing an LPG stove. These obstacles must be removed to ensure that the population identifies the advantages of LPG and intensifies its use. In addition, the LPG stove models on the market are ill suited for the different pots used in the Burkinabe cuisine; adjustments are required to ensure a correct fit. Moreover, an important share of the urban population not now acquainted with the advantages of LPG will be obliged to shift to this fuel over the longer term.

13. **Proposed approach:** An advertising campaign would be developed and launched to introduce the higher income population groups to the advantages of LPG and to promote its more extensive use in LPG-using households. Investigations would also be carried out to identify the adjustments required to LPG stove models to make them compatible with the different pots used for cooking. Expatriate and national technical assistance would be required including: a stove technologist; an advertising specialist and a sociologist.

14. **Implementation arrangements:** SONABHY will be responsible for coordinating the execution of the activities with IBE, and the private oil companies.

Total estimated cost:	**US$ 75,000**
Implementation period:	**10 months**
Funding source:	**to be identified**

Kerosene Promotion Options

15. **The problem**: There are several obstacles to broad scale penetration of kerosene. The first is the absence of a kerosene stove adapted to local cooking requirements. The second concerns kerosene prices: the price advantage of kerosene at the service stations is largely eroded by the high margins in the retail chain. Given the high transaction costs of retail operations, reducing the retailers' margins is not an option. A reduction in these costs can only come about by improving the service provided by the wholesalers, e.g. by serving retail stores directly from pumps mounted on small pick-ups. price advantage of kerosene at the service stations is largely eroded by the high margins in the retail chain.

16. **Proposed approach**: Two components would be developed. The first would test kerosene stove models both in the laboratory and on the market to ensure maximum energy efficiency and consumer acceptability. A kerosene promotion campaign would be developed. The second component would consist of a study to review and analyze the true cost structure of kerosene retailing, current levels of weekly sales and identify and make recommendations on ways to capture kerosene's price advantage through improvements in wholesalers' services.

17. **Implementation arrangements**: IBE and SONABHY would be responsible for the kerosene stove component. The services of a stove technologist, sociologist, and advertising specialist would be needed. SONABHY would be responsible for the promotion campaign and for contracting a petroleum products expert to carry out the study.

Total estimated cost:	**US$ 100,000**
Implementation period:	**10 months**
Funding source:	**to be identified**

Improving Inter-Agency Coordination Workshop

18. **The problem:** The management and conservation of natural resources requires the collective action of many ministries and agencies that frequently have few avenues of coordination. One key issue to the success of the proposed urban household energy strategy is the establishment of mechanisms to ensure the recovery of wood that is the by-product of land clearing for agricultural development. In many cases, land areas targeting for agricultural development are in zones that have been identified as priority areas for active woodland management to supply fuelwood to the urban centers. To ensure that this wood is recovered, arrangements have to be identified to ensure that the responsible ministries take the necessary steps to ensure the availability of wood as an energy source.

19. **Proposed approach:** A 5-day workshop would be held in which designated officials from concerned ministries would engage in a participative process of planning and decision making that will aim to identify the problems and constraints involved in expanding agricultural output, while at the same time, ensuring a sustainable supply of fuelwood for the urban and rural populations over the longer term. Alternatives will be identified to improve inter-ministerial coordination and cooperation on this question and an action plan will be designed and presented for consideration to the inter-ministerial committee for the Lutte Contre la Désertification.

20. **Implementation arrangements:** The Ministry of Plan would be responsible for management of the seminar and would contract the services of two consultants experienced in the methodology of action-planning workshops. The MET and the Ministry of Agriculture would be the principal participating ministries.

Total estimated cost:	**US$ 45,000**
Implementation period:	**6 weeks**
Funding source:	**to be identified**

Village-based Management of Old Fallows and Degraded Woodlands Project

21. **The problem**: Faced with rapid population growth, new alternatives and more efficient management techniques need to be identified and tested. There are large areas of old fallow and degraded lands found within a 50 mile radius of the urban centers that supply fuelwood to urban area. Fuelwood coming from these areas already contributes substantially to overall supply. There is, however, no formal management of wood resources on these lands and they are exploited without attention to ownership or sustainability. Although there is little information on the growth, biomass production and management of these degraded areas, their location, less than 50 km from the city centers, provides an economic incentive for managing any wood product surpluses.

22. The introduction of sustainable management techniques, both for fallow and degraded woodlands as well as for national forests and **domaine protege** zones will require institutional strengthening as well as the possibility of a realignment of functions and responsibilities. This aspect of natural resource management is being examined within the framework of the National Environment Action Program. Nonetheless, there are a number of institutional issues that can be addressed over the short term that will be consistent with the objectives and guidelines of this Plan.

23. **Proposed approach**: A project would be undertaken as a complement to on-going management experiments in the national forests. It would: (a) continue the process of preparing forestry management plans for the four urban supply zones, (b) strengthen the framework of the MET through a series of measures that would aim to identify training needs of MET personnel to carry out their expanded mandate and (c) test the feasibility of managing a large area of old fallow and degraded lands found within a short distance of Ouagadougou. The keystone of the management process will be local participation and the development of a partnership between village-based management structures and the national ministry.

24. The primary objective would be to develop (or improve) village-level multiple use management of forest, fallow, and field trees in areas having a potential for producing a fuelwood surplus for the Ouagadougou markets. The specific management objectives in each village will be determined through an assessment of local needs and desires. A secondary focus will be to develop management options for products identified as important by local villages. A forestry management plan would be prepared by the MET in close collaboration with the resident populations. The management plan would consist of the technical, social, financial, and economic guidelines for managing the woodlands in the identified zone. This plan would be implemented by a woodlands management cooperative that would be created under the project and would be made up of volunteers from a local village. The rights and obligations of the cooperative and the MET, with special attention to land and tree tenure, would be the subject of a "cahier de charge". The experience would be closely monitored and periodic seminars held to review findings and conclusions and discuss policy implications.

25. The project would consist of three components: (a) institutional strengthening; (b) forestry management planning and (c) management of a pilot zone of old fallows and degraded woodlands.

(a) Institutional strengthening: This component would assist in (i) the creation of the Urban Fuelwood Working Group and (ii) identification of staffing and training issues anchored in a needs assessment seminar to be organized for MET personnel; (iii) the design of short and longer term training programs for national and local forestry staff; (iv) establishment of a computerized monitoring and control system for transport permits and training of local staff in its operations; (v) streamlining of forestry fine recovery system;

(b) Forestry management planning: This component would include (i) satellite imagery and preparation of maps to delineate forestry management areas in the four urban supply zones; (ii) definition of legal/administrative framework for creation of natural woodlands management cooperatives within the village land management structure including a model agreement setting out rights and obligations of government and the cooperative network; (iii) design of research program for forestry management including, inter alia, establishment of permanent sample plots to collect data on species response to treatment; sylvo-pastoral management techniques and the impact of grazing on forest productivity; development of field guidelines for preparation of forestry management plans; and (iv) review of existing regulatory framework and recommendations for modifications/consolidation/deletion together with national level seminar for concerned staff on their interpretation and application; and

(c) Village-based fallows and degraded lands pilot experiment: A pilot zone covering about 20,000 hectares of marginal agricultural areas has been identified in an area located between 20-40 kms northwest of Ouagadougou. Land is, for the most part, communally owned with disputes settled by the village chief. Dead wood for fuel is collected throughout the year by women and is used largely for self-consumption; none is sold. Short and long poles for construction are harvested at the beginning of the dry season and is cut green. Activities will include: woodlands management for fuelwood and construction wood; field and forest fruit tree management; production of secondary forest products e.g. bark, seeds leaves roots flowers etc; rangeland and fire management; planned fallow; and management and restoration of denuded areas.

26. **Implementation arrangements:** The Direction des Forets et du Reboisement (D/EF) of the MET will be the main executing agency and will liaise closely with other Burkinabe institutions in the rural sector.

Total estimated cost:	**US$ 5 million**
Implementation period:	**5 years**
Funding arrangements:	**To be identified**

IMPACT ON FUELWOOD DEMAND OF DEMAND SIDE INTERVENTIONS

Year	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Total Fuelwood Demand, 4 Cities	275574	298397	323229	350252	379968	411692	446568	484556	525945	571047	620205	673793
Total Urban Demand	331473	356086	382763	411691	443071	477126	514093	554245	597684	645287	696801	752843
Demand after Improved Stoves Program	331473	356086	382763	411691	433231	462974	494925	529252	566138	605772	648388	694141
Demand after LPG Program	331473	356086	382763	411691	433231	460842	489788	520776	553728	588763	628015	665624
Demand after LPG and Kerosene Program	331473	356086	382763	411691	433231	459122	486559	515637	546452	579109	613717	650394

Growth Rate Progression 0,05976		1990	2000	Demand increase
Total Urban Demand	411691	880145	468455	
Demand after Improved Stoves Program	411691	796202	384511	
Overlapping Area			341157	
Demand after LPG & Kerosene Program	411691	735618	323927	
		83943.63		

Incremental Improved Stove Savings					932	3913	7473	11690	16687	22546	29400	37389
Improved Stove Savings Incl. Other Cities					1088	4535	8603	13382	18989	25476	33031	41775
Savings in Informal Sector					8752	9617	10567	11611	12759	14019	15404	16928
Total Improved Stove Savings					9840	14152	19170	24993	31727	39496	48435	58702
Incremental LPG Promotion Savings												
LPG Promotion Impact on Improved Stove Program												
Net Incremental LPG promotion												
Incremental Kerosene & LPG Savings												
Impact on Improved Stove Savings												
Net Savings of Kerosene & LPG Promotion												

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Fuelwood Demand 4 Cities	732231	795959	865473	941312	1024067	1114384	1212970	1320600	1438124	1566470	1706656	1859798
Total Urban Demand	813807	880145	952353	1030973	1116597	1209875	1311516	1422300	1543078	1674783	1818435	1975154
Demand after Improved Stove Program	743331	796202	929898	1006299	1089874	1180919	1280128	1388281	1506148	1634701	1774915	1927884
Demand after LPG Program	707740	760350										
Demand after LPG & Kerosene Program	689262	735618										
Growth Rate Program	0,05976											
Total Urban Demand												
Demand after Improved Stove Program												
Overlapping Area												
Demand after LPG & Kerosene Program												
Incremental Improved Stove Savings	46677	57433										
Improved Stove Savings Incl. Other Cities	51877	63508										
Savings in Informal Sector	18599	20436	22455	24674	27112							
Total Improved Stove Savings	70476	83944	22455	24674	27112							
Incremental LPG Promotion Savings		45615										
LPG Promotion Impact on Improved Stove Program		9764										
Net Incremental LPG Promotion		35851										
Incremental Kerosene & LPG Savings		77814										
Impact on Improved Stove Savings		17230										
Net Savings of Kerosene & LPG Prom.		60584										

ECONOMIC VALUE OF IMPROVED STOVE PROGRAM

Total for Ouagadougou, Bobo-Dioulasso, Koudougou, Ouahigouya
Stoves per user: 1,9
Average lifetime: 3 years
Fuelwood Savings per year and per stove: 235 kg = 5875 CFAF
Economic value of 1 kg fuelwood: 25 CFAF
Cost of Malgache stove: 300 CFAF
Average cost of improved metal stove: 1125 CFAF

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	TOTAL
Population of the 4 cities	709311	779392	856396	941008	1033979	1136136	1248386	1371727	1507254	1656870	1819800	
Households in the 4 cities	84442	92785	101952	112025	123093	135254	148617	163301	179435	197246	216643	
Unchanged penetration rate	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	
Penetration rate with progression	0.35	0.395	0.44	0.485	0.53	0.575	0.62	0.665	0.71	0.755	0.8	
Stove users without program	29555	32475	35683	39209	43082	47339	52016	57155	62802	69036	75825	
Stove users with program	29555	36650	44859	54332	65239	77771	92143	108595	127399	148921	173314	
New stoves without program	4400	5548	6096	6698	7360	8087	8886	9764	10729	11845	12899	92314
New stoves with program	4400	13481	15597	17999	20724	23811	27306	31259	35727	40892	46347	277543
Replacement stoves without program	4000	4200	4400	4400	5548	6096	6698	7360	8087	8886	9764	69441
Replacement stoves with program	4000	4200	4400	8400	9748	10496	11098	12908	14184	15585	17125	112144
Total stoves sold without program	8400	9748	10496	11098	12908	14184	15585	17125	18817	20731	22663	161755
Total sold stoves with program	8400	17681	19997	26399	30472	34307	38404	44168	49911	56477	63472	389688
Additional new stoves due to program	0	7933	9501	11301	13363	15723	18420	21495	24998	29048	33449	185230
Additional replacement stoves	0	0	0	4000	4200	4400	4400	5548	6096	6698	7360	42703
Additional total stoves	0	7933	9501	15301	17563	20123	22820	27043	31094	35746	40809	227933
Additional fuelwood savings/ton	0	932	3913	7473	11699	16687	22546	29400	37389	46677	57433	234150
Value of fuel savings in millions CFAF	0	23	98	187	292	417	564	735	935	1167	1436	5854
Cost of stoves in million CFAF	0	7	8	13	14	17	19	22	26	29	34	188
Cost of promotions, millions CFAF	0	30	30	30	30	30	30	30	30	30	30	300
Net value of program in millions CFAF	0	(13)	60	144	248	371	515	683	879	1107	1372	
NPV at 10 percent discount rate	2595 mill CFAF = $US 8650 mill.											
IRR	569,27%											

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
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
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
	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*
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 Donor 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 Stu.	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

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
	Bagasse Cogeneration Preinvestment Study	07/90	120/90
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	12/90	124/90
Malaysia	Sabah Power System Efficiency Study	03/87	068/87
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	--
	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
Panama	Power System Efficiency Study	06/83	004/83

Country	*Activity*	*Date*	*Number*
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	--
	Women and Energy--A Resource Guide The International Network: Policies and Experience	04/90	--

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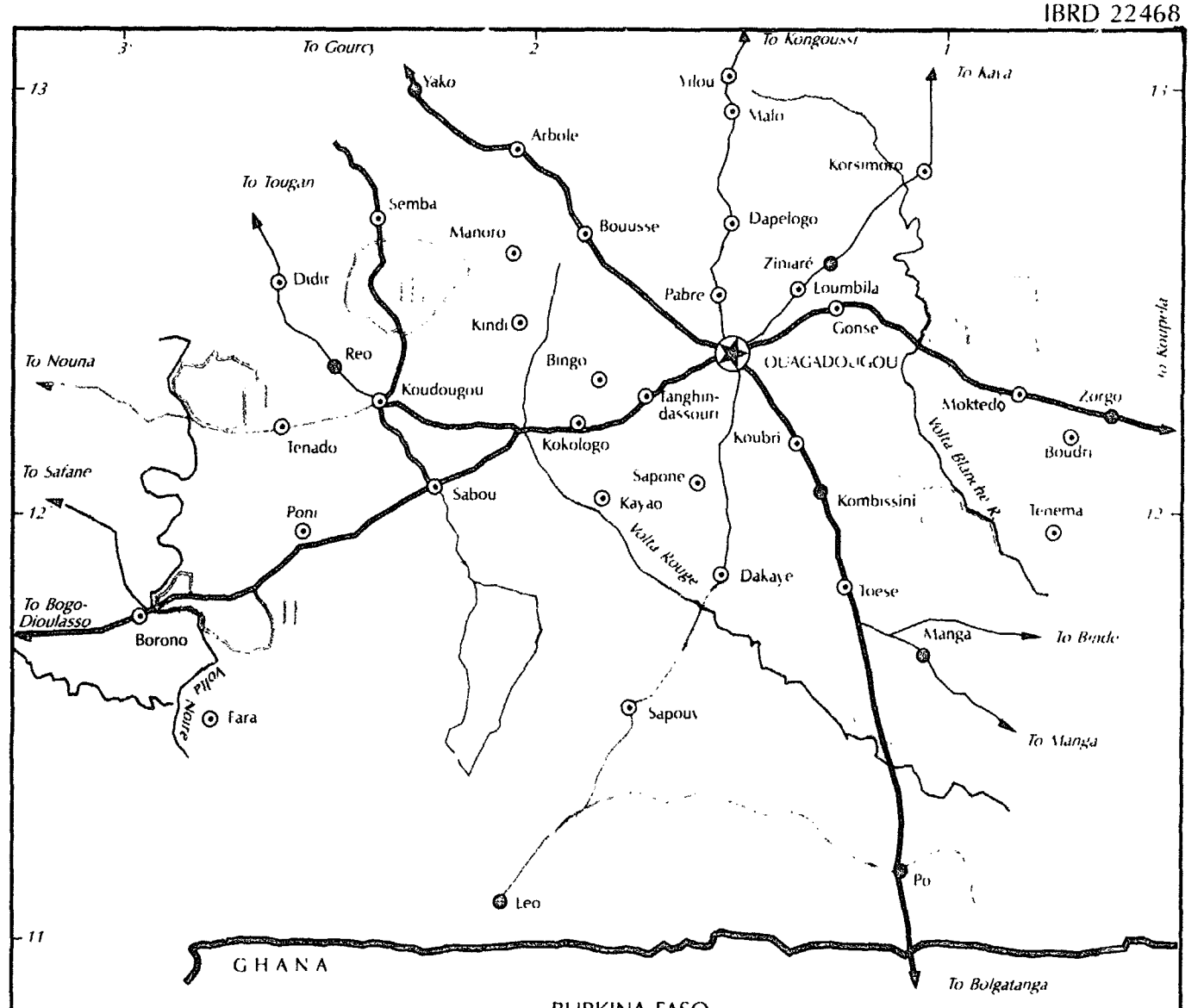


BURKINA FASO

LAND USE AND FORESTRY RESOURCES (OCTOBER - NOVEMBER 1987)

OCCUPATION DU SOL ET DES RESSOURCES FORESTIERES (OCTOBRE - NOVEMBRE 1987)

ACTUAL AND POTENTIAL SUPPLY ZONE FOR OUAGADOUGOU AND KOUDOUGOU

ZONE D'APPROVISIONNEMENT ACTUELLE ET POTENTIELLE POUR OUAGADOUGOU ET KOUDOUGOU

Supply Zone Boundary
Limite de la Zone d'Approvisionnement

Priority Zones for Ouagadougou Forestry Management
Zones Prioritaires d'Amenagement Forestier pour Ouagadougou

Priority Zones for Forestry Management for Koudougou
Zones Prioritaire d'Amenagement Forestier pour Koudougou

ROADS:
ROUTES.

Paved
Bitumee

Unpaved
Ordinaire

Unpaved Class A
Classe A Ameliorée

Upgraded Class B
Classe B Ameliorée

Rivers
Cours d'Eau

National Capital
Capitale

Region Capitales
Capitales Regionales

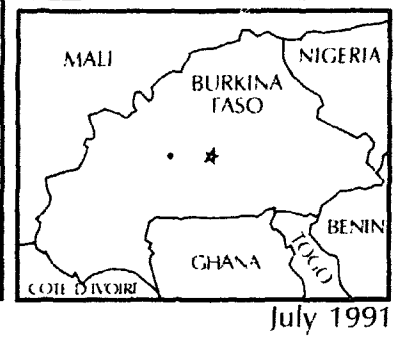
Important Villages
Villages Importants

Forest Plantations
Plantations Forestières

National Forests
Domaine Classe

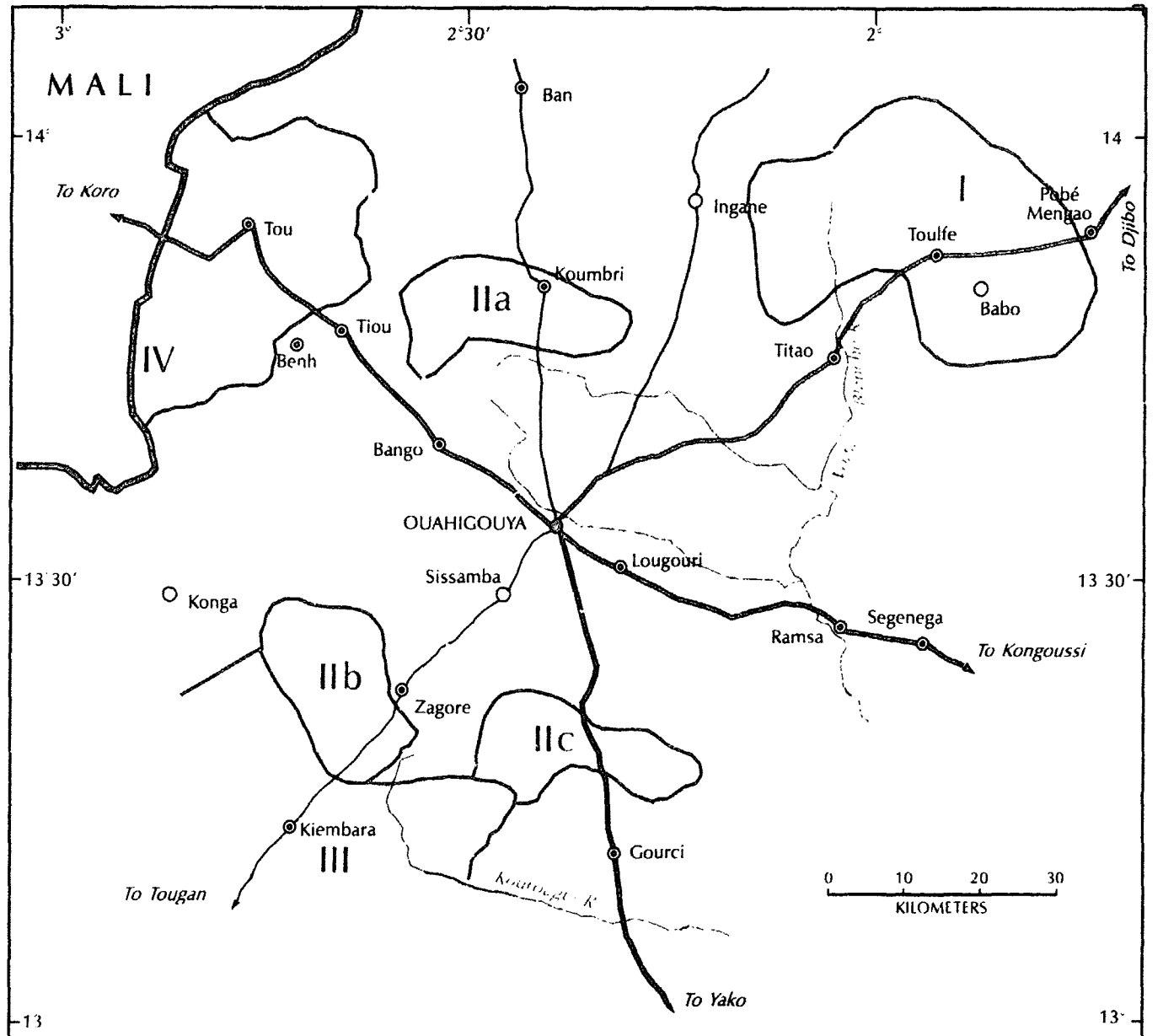
International Boundaries
Frontières Internationales

0 10 20 30 KILOMETERS



July 1991

IBRD 22469



BURKINA FASO

LAND USE AND FORESTRY RESOURCES (NOVEMBER 1987)

OCCUPATION DU SOL ET DES RESSOURCES FORESTIERES (NOVEMBRE 1987)

ACTUAL AND POTENTIAL SUPPLY ZONES FOR OUAHIGOUYA

ZONES D'APPROVISIONNEMENT ACTUELLE ET POTENTIELLE POUR OUAHIGOUYA

Supply Zone Boundary
Limite de la Zone d'Approvisionnement

II Priority Zones for Forestry Management
Zones Prioritaires d'Aménagement Forestier

Roads:
Routes:

Paved
Bitumée

Unpaved
Ordinaire

Upgraded Class A
Classe A Améliorée

Upgraded Class B
Classe B Améliorée

Rivers
Cours d'Eau

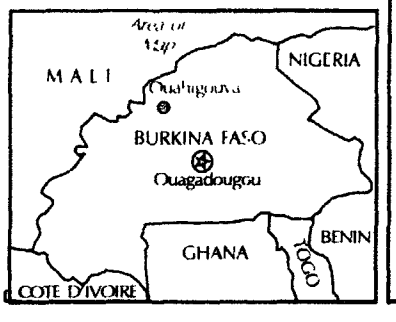
National Capital
Capitale

Region Capital
Capitale Régionale

Important Villages
Villages Importants

Villages
Villages

International Boundaries
Frontières Internationales



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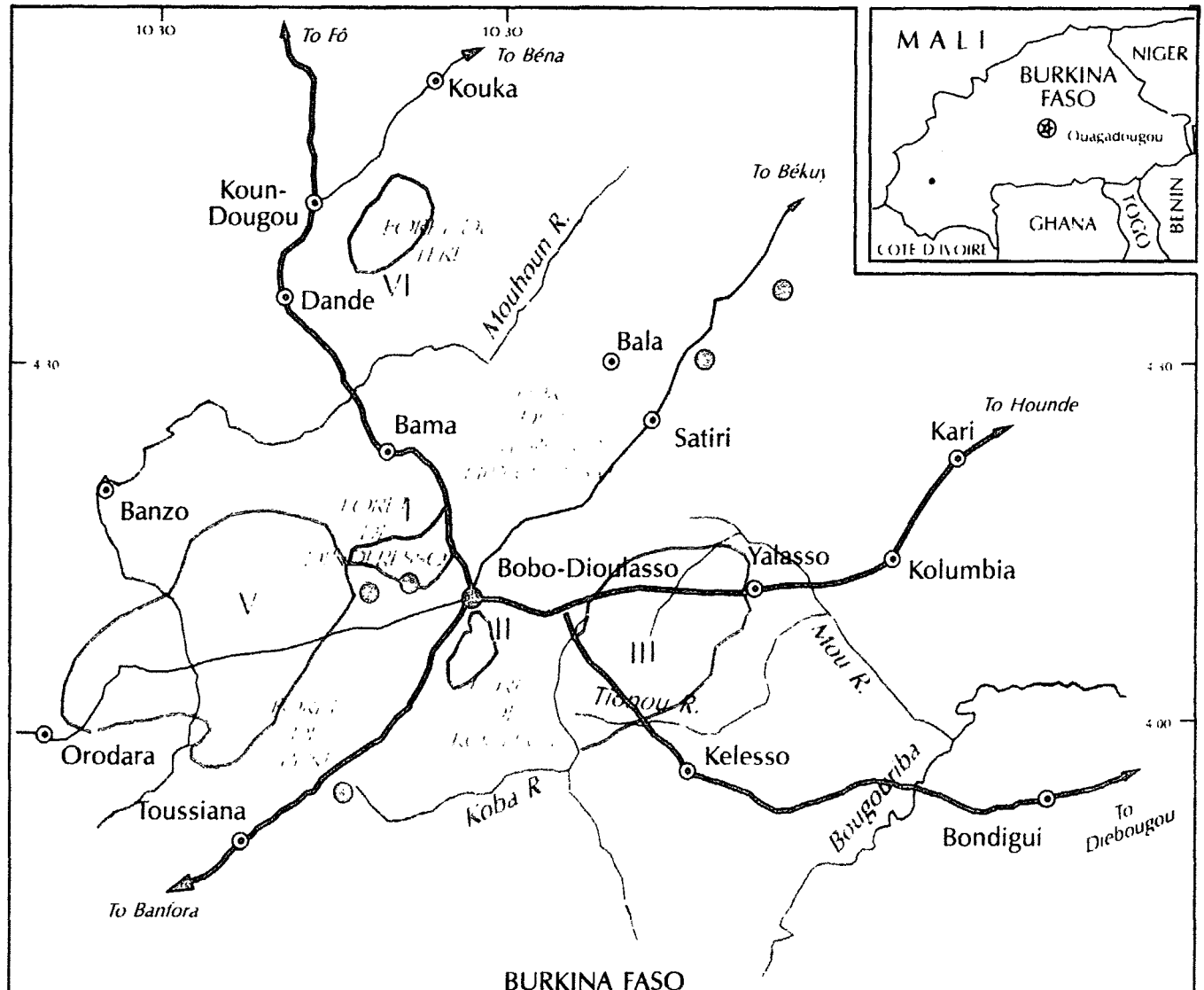

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LAND USE AND FORESTRY RESOURCES (OCTOBER - DECEMBER 1987)
OCCUPATION DU SOL ET DES RESSOURCES FORESTIERES (OCTOBRE -DECEMBRE 1987)

ACTUAL AND POTENTIAL SUPPLY ZONE FOR BOBO-DIOULASSO
ZONE D'APPROVISIONNEMENT ACTUELLE ET POTENTIELLE POUR BOBO-DIOULASSO

Supply Zone Boundary
Limite de la Zone d'Approvisionnement

II Priority Zones for Forestry Management
Zones Prioritaires d'Amenagement Forestier

ROADS.
ROUTES.

Paved
Bitumee

Unpaved
Ordinaire

Upgraded Class A
Classe A Améliorée

Upgraded Class B
Classe B Ameliorée

Rivers
Cours d'Eau

Region Capital
Capitale Regionale

Important Villages
Villages Importants

Forest Plantations
Plantations Forestières

National Forests
Domaine Classe

International Boundaries
Frontieres Internationales

0 10 20 30 KILOMETERS

July 1991