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ESMAP

Energy Sector Management Assistance Programme

APRIL 1992

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Tunisia

Energy Management Strategy in the Residential and Tertiary Sectors

Report No. 146/92

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

PURPOSE

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

GOVERNANCE AND OPERATIONS

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

FUNDING

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

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TUNISIA

ENERGY MANAGEMENT STRATEGY IN THE RESIDENTIAL AND TERTIARY SECTORS

APRIL 1992

EXCHANGE RATE

In June 1989

U.S.$ 1 = 0.91 Tunisian Dinar (TD)

TD 1 = 1000 millimes

CONVERSION FACTORS

Petroleum Products	tons/m³	TOE/ton
LPG	0.560	1.106
Kerosene	0.798	1.032
Gas oil	0.844	1.027
Domestic fuel oil	0.846	1.017

	tons/ '000 m³	TOE/ '000 m³
Algerian Natural Gas	0.656	0.9

Woodfuels	tons/m³	TOE/ton
Fuelwood (air dried)	0.8	0.375
Charcoal	-	0.7

One m³ of cord-wood = 0.35 tons
Carbonization efficiency = 20% by weight

Electricity	TOE/GWh
Final Energy	86
Primary Energy	283

ACRONYMS

AME	Energy Management Agency
DEP	Directorate for Studies, Evaluation and Planning
DER	Renewable Energy Directorate
DGE	Energy General Directorate
DGF	General Directorate of Forests
DURE	Directorate for the Rational Use of Energy
ESMAP	Energy Sector Management Assistance Programme
ETAP	National Petroleum Company of Tunisia
LPG	Liquified Petroleum Gas
INNORPI	National Institute for Standards and Industrial Property
INS	National Institute for Statistics
MA	Ministry of Agriculture
MEN	Ministry of National Economy
MP	Ministry of Planning
ONE	National Energy Observatory
ONTT	Tunisian National Office of Tourism
UNDP	United Nations Development Programme
REF	Forestry Development Administration
SEME	State Secretariat for Mines and Energy
SNDP	National Petroleum Distribution Company
STEG	Electricity and Gas Company of Tunisia
STIR	Refining Industries Company of Tunisia
UTICA	Tunisian Union of Industry, Commerce and Artisans

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EXECUTIVE SUMMARY

1. The present report constitutes the synthesis of the work conducted by a joint team of the Energy Management Agency (AME) and the World Bank/UNDP/Bilateral Aid Energy Sector Management Assistance Program (ESMAP) between July 1988 and July 1989, in the framework of the "Energy Efficiency in the Household and Service Sector of Tunisia Study". The cost of the Study has been financed mainly by the Government of the Netherlands with additional financing from the French Trust Fund and the Canadian International Development Agency.

2. The report comprises four chapters. The introductory chapter contains an overview of the energy sector, focusing on the residential and tertiary sectors, and presents the justification, objectives and expected outputs of a strategy to deal with the main issues of these sectors. The second chapter is divided into two parts which describe respectively the characteristics of the demand and of the supply of energy in the residential and tertiary sectors; the contents of this chapter are not summarized in this section. In the third chapter, after defining the trends of energy demand in both sectors, the existing and anticipated issues and constraints are defined for each type of energy source. The final chapter contains the description of the recommended strategy to improve the situation in both sectors. A detailed presentation of seven action programs which constitute the strategy is given in Annex 1.

3. The report was completed in November 1990 and discussed with the Government of Tunisia in October 1991. The final version of the report, prepared in March 1992, includes complementary data supplied by the AME.

The Energy Context

4. The energy sector's contribution to economic growth remains considerable. However, the sector's importance has lessened, partly as a result of the chronic decline in oil prices, but also due to a structural reduction in the national energy surplus available for export. Tunisia's commercial energy situation is characterized by (a) a limited domestic resource base with recently stagnating hydrocarbons production, coupled with (b) sustained growth of consumption which, over time, will result in (c) Tunisia becoming a net energy importer before the year 2000. Also, locally produced woodfuels continue to play a major role in satisfying household energy needs and generating revenues in rural areas.

5. The public sector plays a dominant role in the institutional structure of Tunisia's energy sector. The private companies operating in the sector are mainly involved in exploration, production, transport and distribution of hydrocarbons.

6. The Government's approach for smoothing the transition from net energy exporter to net energy importer in the near future is based on three strategies: (a) improve hydrocarbon

production and renew emphasis on exploration; (b) plan for energy supply over a long-term horizon; and (c) energy demand management.

7. The residential and tertiary sectors play an important role in the energy balance: about one-third of final demand, almost all fuelwood and charcoal consumption and more than 40% of the total demand for electricity. The relative importance of the residential and tertiary sectors in the aggregate demand for energy and the existing inefficiencies and constraints in both sectors (see the second chapter) justify the design and implementation of an energy management strategy. The Strategy will concentrate on four issues: (a) control and restriction of the extent of environmental damage linked with woodfuel consumption; (b) rationalization of investments for electric power generation; (c) promotion of the efficient use of energy sources; and (d) encouragement of substitution using least-cost energy resources. The strategy is consistent with Tunisia's overall energy sector policy and will also take into account and complement different ongoing activities in the sectors.

Demand Projections

8. The trend for consumption of final energy in the residential sector estimated according to forecast demographics and economic growth and to current specific consumptions and percentage of users for each energy source shows a growth rate (2.5%) slightly less than the population growth rate. Total demand thus will rise from the current 1 million TOE to more than 1.3 million TOE/year by the year 2000. The demand for woodfuels is expected to grow at a moderate pace over the next decade, with annual growth rates probably decreasing towards a stabilized level of consumption. Given carbonization yields, the wood offtake should go from 1.9 million tons/year in 1987 to more than 2.2 million tons/year in 2000 1/. A more rapid growth rate is anticipated for hydrocarbons demand: at 4% p.a., demand will reach 590,000 TOE/year by 2000, an increase of nearly 240,000 TOE over 1987 demand. Electricity demand is expected to nearly double between 1987 and 2000, with an average annual growth rate of more than 5%. Finally, even though final demand for hydrocarbons and electricity in the residential sector will increase at a sustained pace for the next few years, the anticipated growth rates are significantly lower than those of the preceding decade.

1/ The DGF estimate of the Wood offtake is much higher, at 6.3 millions of m^3 per year, which are equivalent to 4.4 millions of tons; however, data used in this report are obtained from a large sample survey with actual measurements of woodfuel consumptions and should therefore be relatively accurate.

9. In the tertiary sector, the lack of reliable data series and the uncertainty about the potential market of natural gas and about present use of woodfuels, 2/ make difficult to generate reliable demand projections. However, through partial projections for particular subsectors and/or fuels (e.g natural gas in the hotel sector, electricity, LPG and kerosene), it has been estimated that the demand for final energy in the tertiary sector probably will double in the next 15 years. It could reach 370,000 TOE/year by the year 2000, with an average annual growth rate of 5.2%. This rate is slightly more than that of value added in the sector, which implies that the energy intensity of the sector will continue to grow. Tertiary demand, equivalent to 20% of the energy demand in the residential sector in 1987, thus could correspond to 30% of residential demand in the year 2000.

Issues and Constraints of Energy Supply in the Sectors

10. Based on the characteristics of energy supply/demand in the sectors, existing and future issues and constraints can be identified at three levels: energy sources, end-use equipment and institutional aspects.

Woodfuels

11. Without accurate data concerning wood availability and supply systems, it is difficult at present to estimate the actual impact of wood offtake will have on the Tunisian environment. Also it is difficult to separate quantitatively the role of wood-energy production from the other causes of forest resource degradation, such as overgrazing, land clearing for agriculture purposes and fires, which usually play a dominant role in deforestation. The impact of wood-energy production will vary according to region: in the southern and central West parts of the country, forest resources are generally insufficient and at risk, while the supply potential is significantly greater than the local demand in the Sahel and the Northwest. However, even in the latter regions, the offtake of wood to supply fuelwood and, especially, charcoal to the main cities could surpass the regenerative capacity of forest reserves.

12. The mechanisms for monitoring and controlling woodfuel production are inefficient. In 1988, charcoal permits were granted for production of 37,000 tons, whereas estimated consumption was nearly triple (110,000 tons). Accounting for the different types of wood supply (State-marketed, exploitation under the system of user's domain, olive tree trimming) shows total supply reaching only 1.45 million tons, which is 25% less than demand of 1.9 million tons in 1988.

13. There are limited prospects for improvements in the efficiency of wood or charcoal stoves and of carbonization techniques. Simple, inexpensive improved cookstoves developed during the Study were not well accepted by consumers during trial tests, due to the poor image of fuelwood

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2/ The importance of woodfuels in the tertiary sector is however gradually decreasing, these fuels already have only a minor share of the sector consumption, with 11.5% of the total consumption.

and the low incidence of fuelwood-related expenditure in the households' budget. The carbonization yields obtained from the traditional earth kilns by Tunisia's professional charcoal producers are very good for that type of technology, due to several factors: (a) the technical know-how of the producers; (b) the relatively high stumpage value of wood; and (c) the types of wood most often used (oak and olive), which carbonize well because of their high density and usually low humidity level. Trying to improve carbonization efficiency of non-professional producers would not be viable, for they are scattered and produce small quantities on a seasonal base and without permit.

Hydrocarbons

14. The projected doubling of LPG imports over the next ten years will increase existing congestion of Tunisia's ports, especially if LPG continues to be shipped in relatively small cargoes. Also, current shortages in existing storage and bottling facilities will be aggravated and stocks will be reduced far below legal requirements.

15. The price structures of the main hydrocarbons used in the residential and tertiary sectors show distortions between CIF, ex-refinery and retail prices, which give certain signals to consumers: (a) LPG is favored over kerosene in the residential sector, thus benefiting wealthier households; (b) the use of kerosene by certain tertiary sector establishments is favored over gas oil while kerosene use should be limited to households.

16. With an adequate promotion policy by STEG, natural gas penetration has been successful in the hotel sector, since an estimated 80% or more of all hotels are connected to the network in areas where gas is distributed. By contrast, natural gas penetration into the residential sector has encountered real difficulties: urban areas along the existing pipeline include some 320,000 households, whereas the number of residential gas customers totaled about 35,000 and the rate of new connections is slowing down. This is mainly due to the high costs of connection, internal piping and equipment conversion, compared to the relatively low expenditures on cooking and water heating, and despite the clear financial advantage of natural gas on LPG and kerosene for these enduses.

Electricity

17. STEG already has achieved considerable progress in managing load growth (especially peak load) and reducing distribution losses. At present, STEG keeps close tabs on demand and is actively developing mechanisms for (a) tracking peak demand, (b) projecting demand, and (c) managing demand through incentives (tariffs, conservation policies) or direct action (load shedding by remote control during peak hours). As initiated by STEG, a data bank covering electric household appliances should be created and sectoral load curves need to be established.

18. Interconnected rural electrification faces constraints: more that more than 250,000 households are not connected to the grid; most of these households are remote and scattered in rural areas, making classic electrification not a viable option. By contrast, decentralized systems such as photovoltaics may offer a least cost solution for providing electricity to these consumers.

New and Renewable Energy

19. Photovoltaic systems could be used to supply low-level electricity (lighting, radio, television) to scattered consumers. The economic viability of photovoltaic systems is highly sensitive to the daily load of the user. The potential market for these systems, which also depends on consumers' willingness-to-pay, should be assessed, based on the results of ongoing AME activities.

20. The market for solar water heaters is limited. New or, even retrofit solar water heaters are not competitive with natural gas- or LPG-fueled water heaters. Comparisons with electric water heaters are more favorable, which explains the substantial penetration rate. However, few households have electric water heaters. Current financial incentive policies by STEG are well adapted.

Household Appliances

21. Locally produced household appliances should be relatively efficient (since they are manufactured under license from foreign producers of good to high efficiency equipment) and uniform standards have been developed for specific appliances. However, available testing equipment does not allow accurate measurements, and as long as the certification process to ensure conformity with standards does not operate, quality guarantees remain limited.

22. The low productivity of local enterprises manufacturing household appliances is translated into either high retail prices or poor financial performance. Providing incentives for increased competition among firms is made difficult by existing market limitations. The main problem remains the economic viability of industries operating in a tight market.

23. Even if good quality servicing of household appliances is relatively easy, installers are not sufficiently regulated (especially in the artisanal sector), so that technical qualifications are variable from one company to another. With the development of electricity and natural gas use, safety requirements for installations are strongly needed. In addition, there is no controlling procedure for verifying internal installations.

Institutional Arrangements

24. There is a lack of adequate and reliable data bases and of coordination among organizations in the sectors. These deficiencies bring about difficulties in establishing sectoral energy balances and planning strategies and investments.

25. There are no uniform standards for several types of household appliances and although certification is underway for the others, no certificate verifying conformity with standards has been granted, as there are no laboratories with the appropriate testing facilities.

26. Building construction is also affected by inadequate regulation and standardization. Construction is subject to several technical regulations, mainly affecting safety and material quality, but at present there are no thermal regulations.

27. Despite the existing legislation on mandatory energy audits, only a handful of the required audits have been carried out in the tertiary sector. In addition, the financial incentives offered by the AME have not had the anticipated effect: few energy conservation investments have been realized, which require significant external expenditures for the establishment. The most important energy management activity achieved in the tertiary sector thus remains the conversion to natural gas.

28. There is a lack of innovative financing mechanisms to encourage: (i) the participation of energy service firms and the private sector through third party financing, with shared-savings contracts and government support; and (ii) utility financing programs (loans, rebates) provided an adequate regulatory framework and flexible tariffs are established to allow recover the costs of such programs.

29. Constraints also affect communication activities, such as publicity campaigns undertaken by the AME. Social marketing and use of modern communication methods are still new in Tunisia. In addition, the target audiences still are not well known and might not receive intended messages.

Strategy for energy management in the residential and tertiary sectors

Objectives

30. In order to tackle the above problems and constraints, the Strategy should pursue the following specific objectives:

(a) better management of wood resources, by reducing unmonitored exploitation, conserving wood where possible and necessary, and rationally developing resources wherever potential is sufficient;

(b) conserve hydrocarbons and electricity by encouraging the use of more efficient energy appliances and distribution systems;

(c) encourage use of substitution fuels which are most economic for both the consumer

and the public at large, in order to slow demand for higher cost fuels;

(d) limit heating and air conditioning requirements in buildings; and,

(e) strengthen AME capacity for statistical data collecting and processing in the residential and tertiary sectors.

Strategy Components

31. In order to achieve the objectives outlined above, several strategy elements are proposed around the following seven action programs: (a) rational management of wood energy resources; (b) energy conservation in the residential sector; (c) energy conservation in the tertiary sector; (d) development of kerosene for cooking; (e) development of natural gas in the residential and tertiary sectors; (f) building design adapted to the climate; and (g) institutional support. Detailed descriptions of the programs are given in Annex 1.

32. Rational Management of Wood Energy Resources. The strategic options for rational management of wood energy resources are:

(a) improve regulation (including tenurial aspects) and the existing fiscal system, and strengthen control of charcoal production and marketing to better monitor charcoal supply. Forestry exploitation thus will be encouraged in areas where wood potential is most favorable and offtake limited to the real regenerative capacity of the resource. In the zones that are the most at risk, reforestation actions would probably also be needed;

(b) study the feasibility of conserving wood used in cooking tabouna bread and in certain tertiary activities such as Moorish baths; and

(c) study the market for modern wood-fired appliances in order to improve fuelwood's image, facilitate rational exploitation of local wood resources in areas where it is abundant (North West and Sahel regions), and slow substitution by imported energy.

33. Energy Conservation in the Residential and Tertiary Sectors. The strategy elements of the action plan for energy conservation in the sectors are:

(a) set up a regulation and certification system to guarantee energy efficiency of household appliances and installations, including training and licensing of installers, and to inform and make consumers and merchants aware of the specific consumption of the appliances that they purchase or sell; and

(b) strengthen and support the program contract procedure with implementing agencies

in order to stimulate energy conservation investments in new establishments of the tertiary sector.

34. Development of Kerosene, Natural Gas and Photovoltaics. The strategy elements to develop use of more cost-effective substitution energy sources are:

(a) develop and market modern kerosene cookers which offer greater convenience and energy efficiency so as to reduce switching to imported LPG;

(b) implement additional incentive measures and provide customers with greater information to encourage natural gas penetration in the residential and tertiary sectors, in the framework of STEG's ongoing program;

(c) pursue ongoing programs and projects for solar water heaters and assess the market of decentralized photovoltaic systems.

35. Efficient Building Design. The program to reduce heating and cooling requirements for buildings has four components: bio-climatic urbanism, design specifications or codes, material selection, and design of energy equipment. Main activities include: research on conditions for comfort and on design rules, specification of standards and labeling methods for buildings and heating/cooling equipment, as well as design and dissemination of technical documents for professionals.

Institutional Strengthening

36. Institutional support for AME is planned as the seventh component of the strategy for an adequate coordination between the components of the Strategy and a better understanding of energy usage patterns in the sectors. The support mainly comprises implementation of a data base, complementary surveys of the residential and tertiary sectors, and monitoring and possible reorientation of the different action programs. Training on the above aspects will be supplied to AME staff involved in the implementation of the strategy's components.

Regulations, Taxes and Tariffs

37. Regulations Norms and Standards. Implementation of standard specifications for household appliances will encourage manufacturers to monitor closely quality control and equipment performance, provided inspections by designated agencies and certification procedures are carried out scrupulously. The program for efficient building design will also provide regulatory measures in the form of specifications or certification seals used to classify new and existing buildings according to their adaptation to the climate. Measuring building "adaptability" will allow to: (a) define rules to be proposed to contractors and the conditions for issuing certification seals that would include access to certain benefits; (b) develop training and research modules; and (c)

design information brochures for implementing agencies. Certification seals should be based on known technical principles: alignment and orientation, protection from solar radiation or--on the contrary to its judicious use during the winter, wall insulation, use of passive thermal walls, window design, use of natural ventilation, etc. The rules and their application should be understood by designers and by users.

38. Taxes and Pricing. Through enhanced dialogue between manufacturers and the Government, however, an agreement should be negotiated with some of the manufacturers which would allow appliances to be marketed at prices lower than current retail prices, with guarantees for quality, reliability and energy efficiency. In return, the Government would partially exempt taxes on various parts and appliances, implement necessary standards and assist in promotion campaigns. Also, taxes and customs duties could be differentiated by energy type or technology for a specific usage to promote the most efficient equipment. As for pricing policy for domestic fuels, current distortions should be lifted to progressively reflect economic costs, especially for LPG and kerosene.

Institutional Framework of the Strategy

39. The AME will be responsible for coordinating the overall energy management strategy for the residential and tertiary sectors and for supervising the implementation of five of the six programs of the strategy. The programs for the rational management of wood energy and the development of natural gas will be handled by the DGF and STEG respectively. The proposed strategy is consistent with the current energy sector policy's objective for rational utilization of energy and most of the proposed activities of the Strategy complement ongoing actions.

Expected Results

40. The main expected results of the Strategy would be:

(a) reduction of unmonitored exploitation of wood resources, thus limiting the degradation of natural forest formations;

(b) design and implementation of projects for promoting improved tabouna and disseminating modern improved wood-fired appliances;

(c) after five years, savings corresponding to 1% of final energy consumption in households relative to current consumption, equivalent to 6000 TOE/year by 1996;

(d) after five years, savings corresponding to 5% of final energy consumption in the tertiary sector relative to current consumption, equivalent to about 12,000 TOE/year by 1996.

(e) in 1996, an annual increase of about 30,000 consumers using kerosene for cooking in substitution for LPG, equivalent to reducing annual LPG imports by almost 5,000 TOE;

(f) in the short term, the addition of 5000 new natural gas customers in the residential sector and strengthened gas penetration in tertiary establishments;

(g) continuation of the progressive penetration of the market for electric water heaters by solar water heaters;

(h) market assessment of individual photovoltaic systems for electrification of dispersed rural sites and, if justified, design and implementation of a project to encourage use of these systems.

(i) a 20% to 30% improvement in energy efficiency for new buildings, equivalent to annual savings of about 3,000 TOE in primary energy by 1996;

41. Expected levels of energy savings in the residential tertiary and building sector have been evaluated by the consultant team based on the characteristics of existing equipment and establishments, the estimated behaviors and decisions of manufacturers and users/owners, the structure and capacity of the AME and experience and results of energy management agencies in other countries (e.g France).

Economic Analysis

42. Total implementation costs for the strategy amount to about TD 3.8 million over five years (US$ 4.2 million), 41% of which is slated for the tertiary sector energy conservation program alone (see Table 4.1 and Annex 1). Slightly over a third of the total sum would be used to finance studies and technical assistance, one-fourth for investments, one-fifth for training and information and one-fifth for personnel and operation costs. This total sum includes US$735,000 for national costs (personnel and operating costs).

43. Expected energy savings are estimated to total more than 32,000 TOE/year in primary energy by 1996, with cumulative savings of more than 62,000 TOE over the period 1991-1995. In addition, there will be an economic benefit due to use of kerosene instead of LPG. In total implementation of the proposed strategy should generate an annual cash savings for the country which will reach TD 2.9 million per year by 1996 (US$ 3.2 million). The NPV is estimated at about m 0.6 million for that period, with an EIRR of return of 22~. Also, yearly benefits will extend far after the end of the Project. The component with higher NPV is by far the program for energy savings in the tertiary sector, followed by the program for energy savings in the residential sector and the program for kerosene promotion for cooking.

44. The strategy also has positive economic and social impacts, mainly on the environment, the quality of living in households, and employment. It is difficult to quantify these additional benefits, however.

45. While the Government should finance the costs of personnel and operation (DT0.7 million over five years), external funding should be sought after for the rest of the costs (about DT3.1 million) including foreign and local expenditure.

Risks

46. The main risks of the recommended strategy are related to actual consumer's responses and efficiency of implementation. Anticipated savings could be optimistic and the rate of penetration of energy saving measures could also be too high. However, even with a decrease of 50% in yearly annual savings, the strategy is still economically sound, on a longer evaluation period though: the NPV of the Strategy would equal 0 after about 6.5 years.

47. Variations in international prices of petroleum products, such as the ones observed since August 1990, will benefit to the Strategy, since higher prices will mean higher benefits in absolute terms. Also, it is reasonable to assume that the current difference between the economic costs of LPG and kerosene on one hand, and between the costs of LPG and natural gas on the other hand, would not vary significantly (i.e. absolute costs would vary in parallel), which maintains the favorable prospects for the penetration of natural gas and, to a lesser extent, kerosene in the residential and tertiary sectors, provided the current distortions in the retail prices are eliminated.

48. If the components of the Strategy were undertaken separately, they should be classified according to their economic rentability and risk probability. The probability-weighed NPV could be used for that purpose. In a first approximation, with the same risk probability for all components, the component with higher NPV is by far the program for energy savings in the tertiary sector, followed by the program for energy savings in the residential sector and the program for kerosene promotion for cooking (see Table 4.2)

Financing

49. Most components of the strategy are ready for immediate implementation as soon as funds are available. Several donors are presently contributing to project financing in the residential and tertiary energy sectors, such as GTZ, CIDA, the EC, France, and some of these could support follow-up investments; their interest in funding part or all of the strategy's components should be assessed by the Government of Tunisia. This could be achieved through preliminary contacts of relevant donors by the AME and the organization of a one-day seminar to officially present the strategy to the donor community, relevant constitutions and the private sector. After obtaining the necessary funding, the AME should prepare a detailed work program and implementation plan for each financed component of the Strategy.

Table 4.2 Economic ranking of the strategy's programs

Program	TOTAL COST (X1000 DT)	NPV (X1000 DT)	EIRR %
Woodfuel management	160	n.a.	n.a.
Residential energy conservation	750	190	29
Tertiary energy conservation	1,550	751	47
Kerosene promotion	445	62	18
Natural gas promotion	n.a	n.a	n.a
Building design	495	2	12
Institutional strengthening	375	n.a.	n.a.
Overall Strategy	3,775	594	22

I INTRODUCTION

1.1 The present report constitutes the synthesis of the work conducted by a joint team of the Energy Management Agency (AME) and the World Bank/UNDP/Bilateral Aid Energy Sector Management Assistance Program (ESMAP) between July 1988 and July 1989, in the framework of the "Energy Efficiency in the Household and Service Sector of Tunisia Study". The cost of the Study has been financed mainly by the Government of the Netherlands with additional financing from the French Trust Fund and the Canadian International Development Agency. After preparatory work between July 1988 and January 1989, the main mission of the Study was carried out between February and July 1989. The AME team was supervised by Messrs. Mounir Majdoub of the National Energy Observatory (ONE) and Nabil Meddeb of the Directorate of Studies, Evaluation and Planning (DEP); it included Ms. Amel M'Rad, task manager, and Ms. Nadia Bechraoui; Messrs. Sadok Maherzi and Naceur Ben Hadj, as well as staff from the Directorate of Energy Conservation (DURE) and the Directorate of Renewable Energy (DER), also contributed to the Study. The ESMAP consultant team was coordinated by Mr. Gérard Madon, energy economist, responsible for preparing the final report; it comprised Ms. Bchir, sociologist, and Messrs. Ridha Boukraa, marketing specialist, Slim Boujemaa, petroleum product specialist, Paul Bussmann, cooking equipment specialist, Mike Crosetti, photovoltaic specialist (ESMAP), Jean-Pierre Mehr, energy conservation specialist, Hubert Stassen, biomass and charcoal production specialist, and Stephen Tyler, data collection specialist. The total number of consultants' time amounted to 11 expert-months. Overall supervision was performed by Mr. Philippe Durand (ESMAP), who prepared the final version of this report. Secretarial assistance and report production services were provided by Mmes. Patricia Biggs, Yeshi Gonfa, Pamela Sawhney and Linda Walker-Adigwe.

1.2 This introduction contains an overview of the energy sector, focussing on the residential and tertiary sectors, and presents the justification, objectives and expected outputs of a strategy to deal with the main issues of these sectors. The second chapter is divided into two parts which describe respectively the characteristics of the demand and of the supply of energy in the residential and tertiary sectors. In the third chapter, after defining the trends of energy demand in both sectors, the existing and anticipated issues and constraints are defined for each type of energy source. The final chapter contains the description of the recommended strategy to improve the situation in both sectors. A detailed presentation of seven action programs which constitute the strategy is given in Annex 1.

1.3 The report was completed in November 1990 and discussed with the Government in October 1991. The final version of the report, prepared in March 1992, includes complementary data supplied by the AME concerning the results of household surveys conducted by STEG and the INS in 1989, the findings of AME in promoting efficient or alternative household equipment, the financial costs of alternative cooking fuels, and other aspects.

Overview

1.4 Tunisia covers a surface area of approximately 164,000 km^2 and is situated between Libya and Algeria along the African coast of the Mediterranean Sea. It is divided into seven administrative regions, each of which has three or four subdivisions known as "governorates" (Annex

1). The two southern-most regions, which are largely desert, occupy more than half the national territory.

1.5 The coastal areas are distinguished by their Mediterranean climate, whereas an arid or semi-arid climate dominates in the rest of the country. While average temperatures vary between 14 and 22 degrees C, the difference between the daily high and low can be quite large, and the seasonal variations are substantial. Winter temperatures frequently fall below 0 degrees C in the north, where snowfalls are not uncommon in the elevated regions of the northwest. In summer, temperatures in the north reach 40 degrees C, and they often exceed 45 degrees C in the south.

1.6 Tunisia's population of about 7.9 millions (1989) is distributed unevenly throughout the country. The most densely populated regions are those in the North -- especially the region of Tunis, with over 500 inhabitants per km^2 -- and the Central East. In the South, however, population density is only about 10 inhabitants per km^2. More than 55% of the population lives in urban areas: there are currently more than 15 cities with more than 50,000 inhabitants and a total of 170 centers have been classified as urban. Between 1975 and 1984, the urban population grew at a rate of 3.2% per annum (p.a.), versus 1.8% p.a. for rural populations and a national average of 2.5% p.a., which has slightly decreased to 2.4% p.a. during the period 1984-1989 (Annex 2). However, despite the large development of urban areas, nearly one quarter of the population is still rural.

1.7 Nearly one-third of the active population works in the agricultural sector, even though only 3% of the country's arable land is irrigated. With the exception of the oasis in the south, most agricultural production is concentrated in the Tell and along the coasts and is subject to large fluctuations in annual rainfall. Cultivation of fruit trees is widespread, with olive oil, dates and almonds generating the main receipts from export of food products (along with fishing products).

1.8 During the period from 1971 to 1984, the Tunisian economy grew at an accelerated pace, with an average growth rate of 7% p.a. Growth was fueled by the combination of an extensive public investment program together with favorable terms for foreign trade, particularly in petroleum. At the beginning of the 1980's, the pace of economic development eased considerably, with annual growth averaging only 3.4% p.a. between 1982 and 1988. Detrimental terms of trade for Tunisia's main petroleum products were the principal force suppressing economic growth: the international petroleum markets at the time suffered several sudden and sharp price drops, the effects of which were often amplified in Tunisia by a declining exchange rate for the US dollar.

The Energy Situation

Energy in the Economy

1.9 The energy sector's contribution to economic growth remains considerable. However, the sector's importance has lessened, partly as a result of the chronic decline in oil prices, but also due to a structural reduction in the national energy surplus available for export.

1.10 The value added by petroleum products and electricity accounted for 9.7% of GDP and 28.2% of gross industrial output in 1988, as compared with an average 11.5% and 32%

respectively between 1982 and 1986. Although net energy exports was only 3.1% of total non-energy exports in 1988, petroleum revenues still accounted for 16.7% of the state's current revenues. The magnitude of this figure, which represented an increase of 2.3 points over 1986 levels, essentially can be attributed to the increase in domestic energy prices.

1.11 Locally produced woodfuels continue to play a major role in satisfying household energy needs. Fuelwood is consumed primarily in rural areas and is rarely the object of commercial transactions. By contrast, charcoal trading probably generates annual sales of more than TD 20 million. Thus, revenues from wood sold for charcoal production are likely to constitute a non-negligible portion of the income of numerous local residents in rural production zones.

Energy Supply and Demand

1.12 In the absence of historical data documenting the availability of wood and the consumption of woodfuels, detailed analysis of Tunisia's energy supply and demand will be limited to non-biomass resources of energy. Tunisia's commercial energy situation is characterized by (a) a limited domestic resource base with recently stagnating hydrocarbons production, coupled with (b) sustained growth of consumption which, over time, will result in (c) Tunisia becoming a net energy importer before the year 2000.

1.13 Limited Resource Base. Between 1970 and 1987, total production of primary energy (excluding woodfuels), 91% of which was crude oil, developed at an annual pace of 1.6%, rising from 4.3 to 5.6 million TOE. In 1987, nearly 88% of all crude oil and natural gas production came from Tunisia's two principal oil fields: El Borma and Ashtart. The balance (12%) combined production from about a dozen other small fields. Domestically produced primary energy is used for generating electric power and as feedstock for the local refinery. The refinery, whose current nominal capacity is 1.5 million tons per annum (tpa), will be expanded to 3 million tpa in the near future. Surplus energy production, an estimated 4.4 million TOE in 1987, is exported.

1.14 Sustained Growth of Consumption. Sustained growth of total consumption of primary energy between 1970 and 1980 was followed by a period of slower growth at the beginning of the 1980's. Total consumption had tripled between 1970 and 1980, but only increased by a third (3 to 4 million TOE) during 1982-1987, an average rate of 5.9% p.a. At the same time, the structure of demand underwent a slight modification: Before 1972, petroleum products accounted for essentially all of commercial energy demand. Then, several industries, including electric power plants in the south, partially substituted petroleum with natural gas following installation of the infrastructure to accompany gas recovery at El Borma, which began in 1973. With the commissioning of the transcontinental gas pipeline between Algeria and Italy in 1983, the share of natural gas in total primary energy consumption again increased, from 14% in 1983 to 33% in 1984.

1.15 Deficit of Supply/Demand Balance. According to the summary report "Energy 2001" produced by the Secretariat of State for Mines and Energy (SEME), the amount of surplus primary energy which is exported annually has decreased continuously since 1970. This diminution has been especially pronounced since the beginning the 1980's, as production has slowed while consumption continued to grow rapidly. The energy surplus thus has dropped from 3.07 million TOE in 1980 to 1.6 million TOE in 1987, a decrease of 10% p.a. A continuation of this trend

would produce an energy deficit in the short term, projected to reach 4 million TOE by the year 2001. With a rigorous policy for renewed hydrocarbon exploration and production, it could be decreased to 2.5 million TOE. Thus, even with major efforts for energy management and conservation, Tunisia is expected to become a net energy importer during the 1990's.

Institutional Structure of the Energy Sector

1.16 The public sector plays a dominant role in the institutional structure of Tunisia's energy sector. The private companies operating in the sector are mainly involved in exploration, production, transport and distribution of hydrocarbons. The main organization charts for the sector are shown in Annex 3.

1.17 Primary responsibility for the energy sector rests with the Ministry of National Economy (MEN), which includes the Cabinet and the central administration, notably the Energy General Directorate (DGE). The principal public and parastatal organizations within the sector include:

(a) the Entreprise Tunisienne d'Activités Pétrolières (National Petroleum Company of Tunisia - ETAP), which markets crude oil and petroleum products,

(b) the Société Tunisienne de l'Electricité et du Gaz (Electricity and Gas Company of Tunisia - STEG), which generates and distributes electric power, and oversees sales of natural gas,

(c) the Société Tunisienne des Industries de Raffinage (Refining Industries Company of Tunisia - STIR), which refines crude oil and sells refined products to distribution companies,

(d) the Société Nationale de Distribution des Pétroles (National Petroleum Distribution Company - SNDP), which contributes to the distribution of petroleum products, and

(e) the Agence de Maîtrise de l'Energie (Energy Management Agency - AME), which is responsible for the implementation of the government's energy management and conservation policy.

1.18 The exploitation, transformation and distribution of fuelwood and charcoal are monitored by the Forestry General Directorate (DGF) and the Forestry Development Administration (REF) within the Ministry of Agriculture (MA). However, none of the other institutions of the energy sector has any service specialized in the woodfuel subsector. It is notable, for example, that the energy balances established by the DGE or AME often do not include biomass forms of energy.

Energy Policy

1.19 The Government's approach for smoothing the transition from net energy exporter to net energy importer in the near future is based on three strategies: (a) improve hydrocarbon production and renew emphasis on exploration; (b) plan for energy supply over a long-term horizon;

and (c) energy demand management.

1.20 Increasing Hydrocarbon Production. Improving the recovery rates at fields already in production is seen as a first step towards enhancing hydrocarbon production. Production could be increased by an additional 15 million tons with major investments. The second point of attack would be development of marginal fields, which hold a total of 35 million tons in recoverable reserves, more than two-thirds natural gas. Foreign investments in exploration of new fields has been on the decline since the oil price drops in the mid-1980's, due in part to Tunisia's relatively modest geological potential. However, the Government has adopted exploration promotion measures to increase investments, especially in deep well drilling and natural gas exploration.

1.21 Energy Supply Planning. The Government's objectives in planning the energy supply over a long-term horizon are to diversify the energy resource base and to promote alternatives to energy supply. Potential "new" energy resources are coal, nuclear energy and, to a lesser degree, renewable energy. Use of coal could be considered for the medium- to long-term. However, it could not be introduced effectively without improvements to the infrastructure and implementation of environmental protection measures. It would be premature to introduce the nuclear option at this stage, given the associated technical constraints on Tunisia's power grid, environmental problems and the usually large capacity of typical nuclear power plants. Use of renewable energy, although expected to remain modest through to the year 2001 1/, will depend on technological innovation - as well as cost reductions - and have implications for energy conservation efforts and development of local industry. Given these considerations, it can be assumed that the national energy supply in 2001 still would be based mainly on hydrocarbons, with natural gas representing a larger share.

1.22 Energy Demand Management. Finally, with the creation of the AME at the end of 1985, the Government sought to revise its longstanding policy of managing only energy procurement and supply. AME, whose goal is to rationalize energy use, is identifying and administering specific measures which will lead to effective implementation of the National Energy Conservation Program (NECP), within the framework of the energy conservation law. The NECP has three principle components: (a) regulatory measures including mandatory audits in the commercial and industrial sectors, and energy equipment normalization and certification; (b) promotional and decision-making assistance; and, (c) training and enhancing public awareness.

1.23 The status, mandate and instruments of the AME have been strengthened and developed through the law enacted in July 1990. The AME is transformed into a public enterprise with industrial and commercial status and a number of fiscal benefits. A full panoply of incentive measures is now in place to encourage energy efficiency investments, mainly in the industry and tertiary sectors, including: subsidizing the cost of audits, subsidizing demonstration operations, VAT exemption, targeted soft loans, minimum customs duty, accelerated depreciation. The law also creates the Observatoire National de l'Energie (ONE) in charge of collecting, processing and disseminating data on the energy sector.

1/ Ministry of Mines and Energy, "Energie 2001. Rapport de synthèse," December 1988.

The Residential and Tertiary Sectors

1.24 By definition, the residential sector includes all uses of energy by households, except fuel for transport and energy consumed in agricultural and small craft activities. Still, it is often difficult to disassociate the energy demand of some small crafts activities from the rest of household energy demand. The tertiary sector is often defined by default and includes all activities which cannot strictly be grouped under other energy usages (mining, industry, small crafts, households, transport). The tertiary sector includes the hotel/restaurant industry; commercial establishments (formal or informal); administrative buildings; hospitals; schools and universities; both private and public sector offices concerned with social welfare, cultural and recreational activities; and public lighting.

Significance of the Sectors

1.25 Using available statistics, an energy balance based on final demand 2/ for 1987 is presented in Table 1.1. The energy balance clearly shows the relative importance of the residential and tertiary sectors:

(a) About one-third (33%) of final demand, approximately 1.2 million TOE, is accounted for by the two sectors. The residential sector alone represents more than one-fourth of total demand.

(b) Almost all fuelwood and charcoal (more than 95%) is consumed in the household and tertiary sectors. Households alone consume an estimated 90% of the total.

(c) The household and tertiary sectors represent approximately 43% of the total demand for electricity.

(d) Only a relatively small share of the final consumption of petroleum products (less than 20%) and natural gas (less than 15%) are used in the household and tertiary sectors.

2/ Excluding any non-energy consumption of energy resources (coke, bitumen and lubricants).

Table 1.1: FINAL ENERGY BALANCE 1987
(in Thousands of TOE)

Sector	Electricity	Petroleum Products	Natural Gas	Biomass	Total	
Industry	152	893	178		1,223	35%
Transport		885			885	25%
Residential	65	341	13	530	949	27%
Tertiary	62	110	19	25	216	6%
Agriculture	15	182		10	207	6%
Total	294	2,411	210	565	3,480	100%
	8%	69%	6%	16%	100%	

Source: National Energy Balance, 1987, ANE.

1.26 The residential and tertiary sectors are chiefly consumers of primary fuels. While electricity represents only 11% of the total final demand of both sectors, annual consumption of natural gas and petroleum-based fuels (LPG, kerosene, gas oil, domestic fuel oil and, in small quantities, light and heavy fuel oil) is about 520,000 TOE. Woodfuel consumption is at about the same level (555,000 TOE).

1.27 Consumption of electric power in the two sectors remains relatively moderate, but it is similar to levels observed in other countries at the same level of development. The share of electricity in Tunisia's total energy demand in all sectors (about 8%) matches that of other North African and in Southeast Asia countries with similar GDP's. Nevertheless, the figures presented in Table 1.1 indicate only final energy. The corresponding primary energy requirement for total production of electric power totals more than 1 million TOE, or more than 20% of total demand for primary energy of all forms. In terms of primary energy, electricity demand in the residential and tertiary sectors thus accounts for more than 9% of the country's consumption.

1.28 The above consumption and trends observed in the residential and tertiary sectors are confirmed by the data on the consumption of commercial fuels (excluding biomass) prepared by the ONE for 1990 (see Annex 4). The household and tertiary sectors still represent 43% of the total demand for electricity, which grew at about 5% p.a. in these sectors on the period 1984-1989. While the participation of the sectors in the total consumption of petroleum products only increased slightly between 1984 (19%) and 1989 (21%), the demand for these products has almost doubled in the tertiary sector alone. Finally the increase of gas consumption is noteworthy: total gas consumption increased at about 11% p.a. during the period 1984-1989 but this increase reached 38% p.a. in the residential sector alone (where total consumption has tripled), while consumption remained almost constant in the tertiary sector.

Need for an Energy Management Strategy

1.29 The relative importance of the residential and tertiary sectors in the aggregate demand for energy and the existing inefficiencies and constraints in both sectors (see the second

chapter) justify the design and implementation of an energy management strategy. The Strategy will concentrate on four issues: (a) control and restriction of the extent of environmental damage linked with woodfuel consumption; (b) rationalization of investments for electric power generation; (c) promotion of the efficient use of energy sources; and (d) encouragement of substitution using least-cost energy resources.

1.30 Mitigating the Risks of Environment Degradation. Tunisia has little in the way of forest resources for woodfuel production, with the exception of small enclaves in the northwest and the central east. Under these conditions, any undue pressure on wood resources represents several dangers to the environment: erosion, decrease of natural regeneration, reduction of the water table, changing hydrological patterns, etc. Ever conscious of these threats, the Government has attempted over the past twenty years to reduce wood consumption for energy purposes, in particular by strengthening forestry and charcoal production regulations and by using pricing policy to promote the use of kerosene and LPG as woodfuel substitutes. However, fuelwood and charcoal consumed annually in the residential and tertiary sectors still represent nearly 990,000 TOE (3.3 million m^3 of wood), taking into account the low yield of carbonization techniques. 3/ Although there are no precise statistics for evaluating the impact of this offtake, the threat of deforestation most likely will continue in some areas. Monitoring the consumption of woodfuels and managing the exploitation of forest resources are thus, without a doubt, a primary necessity.

1.31 Rationalization of Investments for Power Generation. Investments for electric power generation weigh as heavily on Tunisia's balance of payments as do actual energy imports. 4/ These investments weigh even heavier especially as the peak load becomes more pronounced or the load factor declines. The load factor (or "coefficient d'utilisation" according to STEG's definition), has improved appreciably in recent years, primarily due to tariff policies which encourage off-peak consumption. The current load factor (64.5%) compares favorably with international standards. Nonetheless, as explained in Chapter 2, the rapid growth in consumption among certain consumer classes, especially during peak hours, can contribute to a decrease in the load factor. It would be necessary therefore to adopt a policy for managing electric power loads.

1.32 Efficient Use of Energy Sources. As for electricity demand, it is important to note that almost all of Tunisia's electricity is thermally generated. Since 1984, heavy fuel oil used as feedstock in power stations has been supplanted in large part by natural gas, most of which is supplied by the transcontinental gas pipeline. This conversion has reduced generation costs and left supply less subject to fluctuations in petroleum prices. However, the market value of natural gas most likely will remain at high levels indexed to oil prices (fuel oil). Thus, the need to conserve natural gas is as important as the need to conserve petroleum products.

1.33 Encouragement of Substitution. The promotion of natural gas and kerosene as substitute fuels is desirable on economic and financial grounds (see Chapter 2). Conversion to

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3/ On average, 5 kg of wood is needed to produce 1 kg of charcoal (average efficiency of 40% in energy terms and 20% on a weight basis).

4/ Investments in the electricity subsector are currently TD 40 to 50 million annually. Imports for power infrastructure account for 6% to 7% of all equipment imports and 1% of total imports. The fuel costs for generating electricity currently is about TD 50 million (2.2% of total exports in 1988).

natural gas is already widespread in the tertiary sector and includes most hotels in areas with gas service. It is anticipated that other large establishments, such as hospitals, will undergo conversion shortly. By contrast, there is only minor penetration of natural gas in the residential sector, where it would substitute for LPG used in cooking and water heating and for gas oil used in houses equipped with central heating. The use of kerosene for cooking purposes as a partial substitute for wood and LPG would yield financial and social benefits for households. Finally, this substitution potential is of particular interest since the energy sources which would be replaced are in short supply, especially LPG, which is primarily supplied through imports.

Strategy for Energy Management in the Residential and Tertiary Sectors

Objectives and Expected Results

1.34 The energy management strategy for the residential and tertiary sectors should encompass the following development objectives:

(a) achieve rational development of local energy resources and reduction of the costs associated with importing petroleum products;

(b) contribute to environmental protection;

(c) provide the best service at least cost to Tunisian households by minimizing (i) investment and maintenance expenditures for household appliances and (ii) energy expenditures as a share of the family budget.

(d) enable public and private establishments in the tertiary sector to provide the consumer with the best service or products while minimizing their production costs through the rational use of energy.

1.35 The anticipated outcomes of the strategy once it has been implemented include: (a) improved management of wood energy resources; (b) significant savings in hydrocarbons and electricity consumption; (c) development of energy resources which are less costly for both the consumer and the general economy; and (d) institutional strengthening in the areas of follow-up activities, planning and capacity of intervention in the sectors.

Coordination with Current Activities

1.36 The development objectives of the strategy are consistent with Tunisia's overall energy sector policy, as summarized above. Implementation of the strategy will also take into account and complement different ongoing activities in the sectors, as described below.

1.37 An energy conservation program was launched in 1987 with World Bank assistance (Energy Conservation Demonstration Project, L-2735-TUN); audits were performed for about one hundred enterprises in three sectors (industry, transport and tertiary); as a follow-up action, the

proposed Energy Conservation and Diversification Project is under preparation. Several other energy conservation activities which target the residential and tertiary sectors are being implemented with the assistance of various donors. In the area of wood resources, the Forestry General Directorate is implementing a forestry development project with assistance from FAO and financing by the World Bank (US$ 20 million). The project components include improved forestry management and the creation of plantations of rapid growth species. An additional 2.9 million m^3 of wood for fuel will be produced during the 40 year span of the project. Renewable energy is also the subject of a number of activities, in particular the Special Energy Program (PSE) conducted by the AME with technical and financial assistance from the Federal Republic of Germany. This program covers solar water heaters and photovoltaic systems. Finally, several studies are underway to examine thermal aspects in homes and other building; in particular a regional, EC-funded study on Thermal Analysis and Efficient Building Design in the Maghreb countries (Algeria, Morocco and Tunisia) has been launched recently and focusses on four main themes: (i) climate data collection and evaluation of comport conditions; (ii) review of building techniques and materials; (iii) preparation of building design software; and (iv) definition of a building thermal regulation and preparation of demonstration projects; funding has been obtained for the activities of the first two themes, which have started.

II. CURRENT SITUATION OF ENERGY SUPPLY AND DEMAND

Energy Demand

Residential Sector

2.1 The energy demand of the residential sector has been the subject of very few in-depth studies. Furthermore, existing data are incomplete due to the absence of reliable historical series. The only information available prior to 1984 comes from general population surveys conducted periodically by the National Statistics Institute (INS). 5/ The MEN initiated a domestic energy survey in 1984, which was divided in two phases. STEG conducted the first stage, interviewing households with electricity (3312 homes), and the second stage was conducted by ETAP and AME on a reduced sample of households without electricity (273 homes). In the same year, a third survey covering a sample of 1259 households was completed as part of a doctoral thesis. 6/

2.2 The results of two important surveys became available after the completion of the first draft of this report: (i) the survey conducted in 1989 by STEG among 2,800 households with electricity (see Annex 4 for a table summarizing the energy consumption of households with electricity, by end-use and source of energy); and (ii) the Population and Employment National Survey conducted by the INS, also in 1989. These surveys confirm the penetration of gas for cooking in the residential sector (LPG mainly and natural gas to a lesser extent), the sharp increase in electricity consumption (close to 10% per year in the residential sector for the period 1984-1989) and in the rates of household equipment in electric appliances, the decrease in the use of kerosene for cooking, and the decrease of unit consumptions of electricity equipment (related with the purchase of new smaller equipment by medium to low-income households and with the expansion of rural electrification in low-consumption households). Because of the lack of disaggregation of INS data and due to the fact that STEG data concern only households with electricity and were made available only in a summarized form, it has not been possible to fully update the detailed tables on consumption per end-use and source of energy, nor the corresponding forecasts. However, the results of these two surveys have been used to qualify the text whenever necessary and possible.

2.3 On the basis of the INS' statistics and the results of the 1984 surveys, a preliminary energy demand balance was established for the residential sector by usage and by principal sources of energy (Figure 1 and Annex 4). The balance underscores four major characteristics of final energy consumption in households:

(a) Cooking - i.e. preparing meals and baking bread, as well as preparing tea - represents nearly three-fourths of final energy consumption.

5/ These include general census, household budget and consumption surveys, and population/employment surveys.

6/ "La demande d'énergie dans le secteur résidentiel en Tunisie: Analyse socio-économique des pratiques énergétiques à partir d'une enquête," Samir Amous and Azedine Ouerghi, 1986.

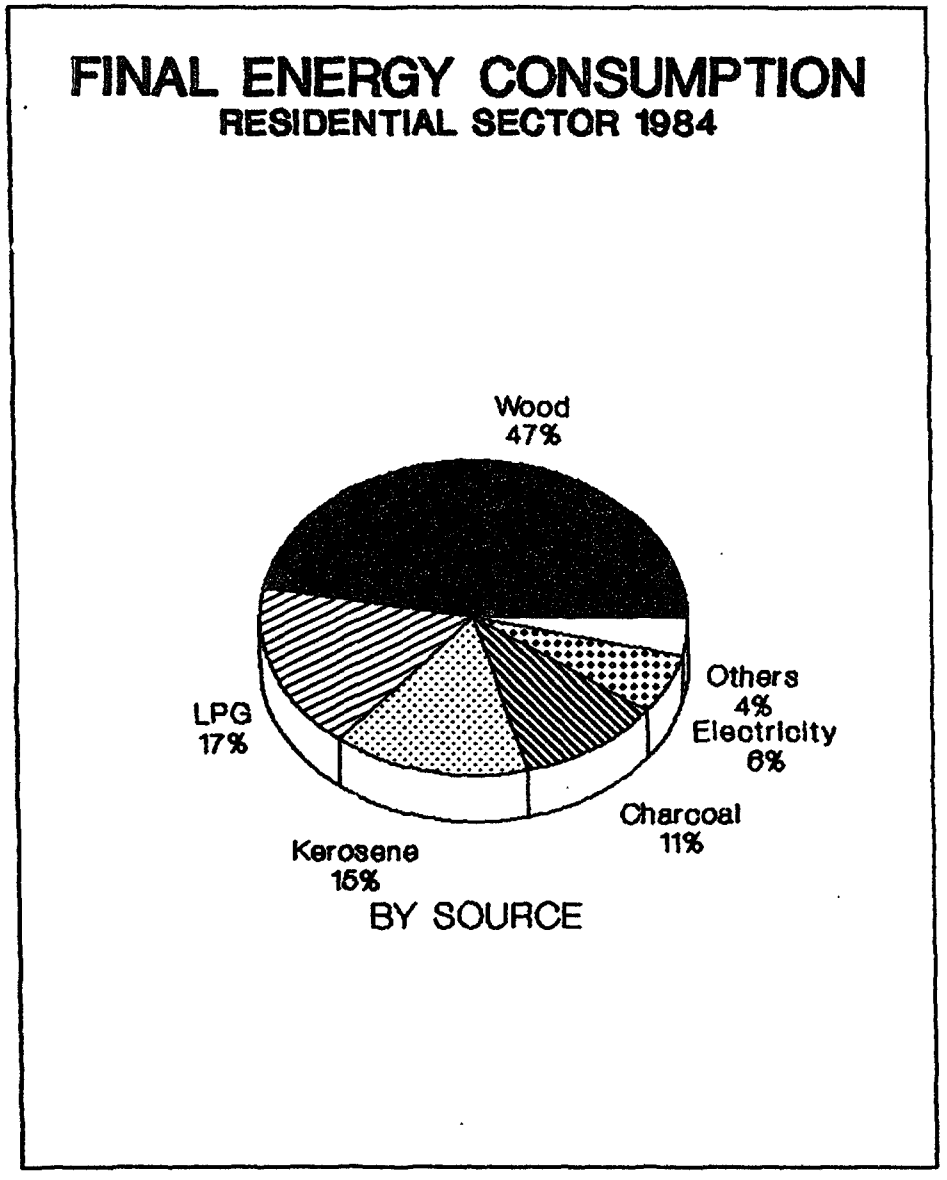
(b) Woodfuels account for about 60% of the energy used to satisfy household demand.

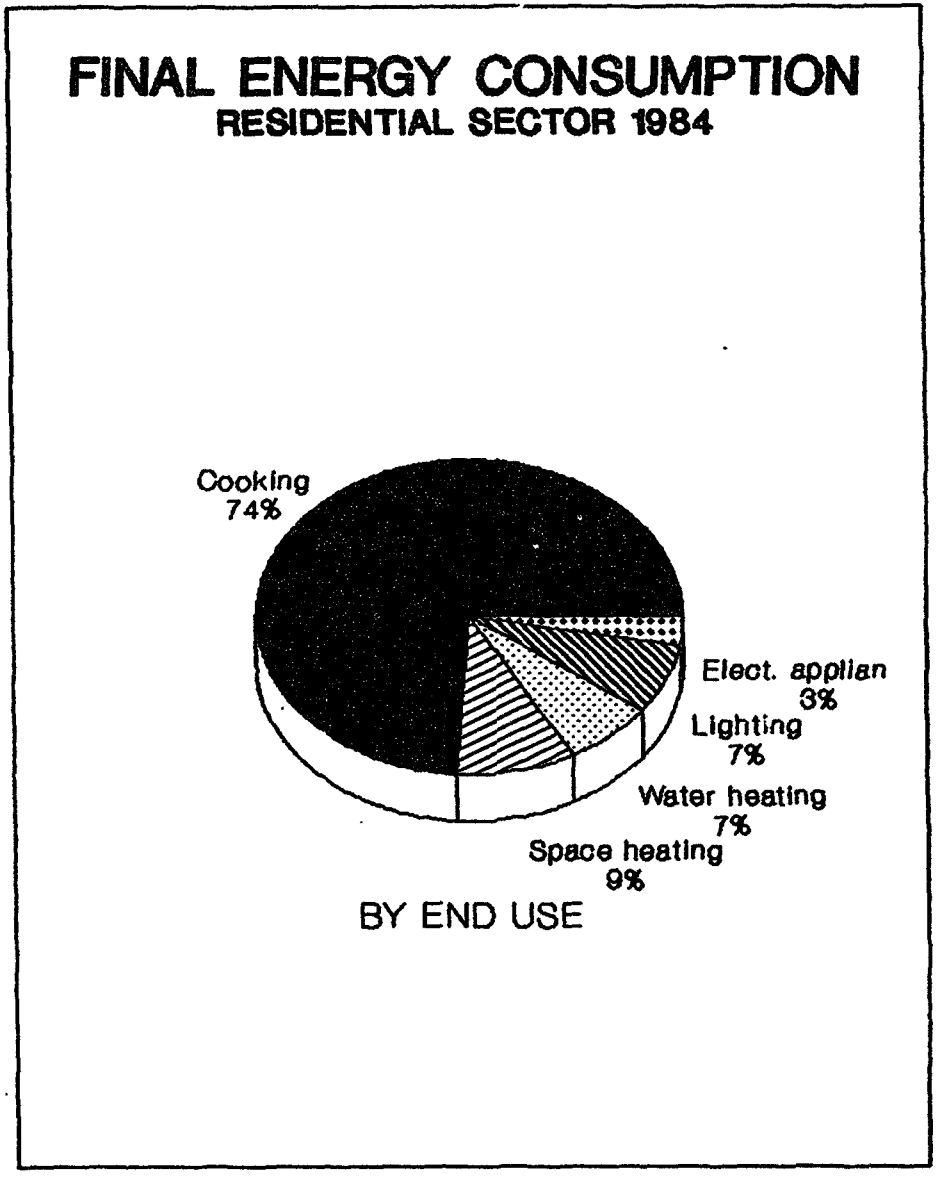
(c) LPG and kerosene are also important and contribute equally to the energy balance, together representing about one-third of the final energy consumed.

(d) The use of electrical appliances in households is well developed, accounting for more than half of residential electricity consumption.

2.4 The data available from the INS and the 1984 surveys allow for an initial analysis of energy demand. Additional data to substantiate and complete the analysis were obtained through interviews conducted by the project sociologist with consumers in Tunis and in the Northwest and Central-East (Sahel) regions, as well as by a survey of household appliance manufacturers and merchants completed by AME for the project. The main results are presented below in terms of (a) household attitudes about energy use, (b) equipment rates and types of household appliances in use, and (c) correlation between energy consumption and standard of living.

FIGURE 1





Source: INS, STEG, AMOUS, MISSION

Attitudes About Energy Use

2.5 Types of Energy Usage. There is a wide diversity of attitudes about energy use in Tunisian households. The diversity of uses is reflected in consumption-related behavior which ranges from energy-wasting practices to daily energy-conservation efforts. Also, households have recourse to a variety of energy sources, which range from straw and olive pits to electricity and natural gas; and to a range of household appliances, including the most rudimentary, such as the three-stone stove fired by fuelwood, and the most sophisticated, such as central heating systems or central air conditioning.

2.6 Attitudes towards energy consumption depend on many parameters with varying importance. Two which appear to be major determinants are wealth and the level of education, parameters usually linked to the households' socio-professional profile. The choice to use a specific type of energy source or household appliance is highly dependent on purchasing power: in urban areas, wood generally is used only by households at or below the poverty level; LPG replaces kerosene for cooking as soon as income permits; also, only the wealthiest households are equipped with fuel-oil-fired central heating. However, education level tempers the choice and influences the consumption attitude: solar water heating is increasingly popular among those employed in upper management; similarly, the energy efficiency of a household appliance is a parameter of choice only among well-educated consumers.

2.7 Wealth and level of education alone do not explain energy consumption attitudes, however. The availability of specific energy resources, the urban/rural milieu and the climate also can have determining roles. The influence of these parameters on energy consumption was apparent in the surveys cited above. For instance, wood is widely used in rural areas, in part because it is easily found there, but also because there has not yet been a break with tradition, as is often the case in the cities. Also, the Sahelian peasant naturally will tend to use wood because of free and constant access to it when pruning or replacing olive trees. As for the climate, it is quite obvious that heating and cooling needs are not the same in the elevated areas of the Northwest, along the coast, or in the hot South areas.

2.8 The interaction of wealth and education level is reflected in the different social groups by characteristics such as: lifestyles, the number and kinds of appliances, culinary habits, modes of space and water heating. A typology of energy attitudes in Tunisian households was developed on this basis. This classification contains several different groups ranging from large consumers -- users of electricity, natural gas, gas oil or domestic fuel oil, some of whom waste energy because they are over-equipped with sophisticated household appliances -- to the "energy poor", for whom energy is in short supply. The latter are limited to consuming only the indispensable minimum energy needed to satisfy their priority needs and are totally dependent on woodfuels.

2.9 Thus, the population can be roughly separated in five relatively homogenous levels:

(a) Level 1: households with intermittent or low incomes. Although composed primarily of households in the agricultural sector (farmers and agricultural workers), this group also includes the most impoverished inhabitants of urban and peri-urban areas. Their housing is substandard ("gourbi", or shanties), and they generally own no or few household appliances.

(b) Level 2: households with modest, but regular, incomes. These are principally workers' households. The quality of housing is slightly better than for level one, and households are likely to own a television set.

(c) Level 3: middle-class households with several wage earners. Office workers, craftsmen and small merchants are included in this class. They often live in Arab-style housing ("dar") and, in addition to a television set, own a refrigerator and a few other appliances.

(d) Level 4: high-income, relatively well-off households. Middle and upper management professionals are found in this level. Housing is usually of good quality -- villa or apartment -- and rather well equipped with electrical appliances, including those for space and water heating.

(e) Level 5: households with a very high standard of living and very high incomes. In addition to upper management professionals, this category mainly includes successful merchants and entrepreneurs. They live in luxurious homes which have an assortment of under or inefficiently utilized household equipment, including central heating and air-conditioning.

2.10 Main Consumption Trends. Despite the diversity of attitudes concerning energy, there appear to be two main trends in energy consumption. These trends hold across regions and in both urban and rural areas, regardless of the wealth or education of the consumer, and neither is a phenomenon limited particularly to the energy sector: (i) consumers search for increased convenience and (ii) attraction for modernism. The manner in which these trends manifest themselves depends on the standard of living and the purchasing power of the households. In terms of domestic energy, this translates into (a) substitution between sources of energy and (b) an increase in the equipment rates of household appliances, which both effectively increase the energy consumption per household.

2.11 Substitution trends have been a characteristic of Tunisia's energy scenario for the past two decades. For example, although there are no time series data for the residential sector, the substitution process for cooking is abundantly illustrated by the evolution of petroleum products sales: wood is progressively replaced by kerosene and, mainly, LPG. Use of kerosene lamps is tapering off in favor of electricity. Figures illustrating these phenomena are presented in the third chapter.

2.12 Clearly the Government's explicit policy has provided incentives for substitution: regulatory framework for forestry exploitation, development of transport and distribution infrastructure for electricity and natural gas, pricing incentives (for the kerosene and LPG), etc. Nevertheless, the policy has be n successful only because it corresponds to the entrenched desire among consumers to have the c est, most convenient and up-to-date energy sources. Wood is without a doubt the first victim of this desire. Today, it is considered a fuel of the past, the fuel of the poor, or the fuel to use when there is no other alternative.

2.13 Along with substitution, the desire for convenience and modernity leads to the acquisition of new household appliances. Thus, annual sales of television sets have soared, more than doubling in quantity between 1977 and 1985. Refrigerator sales are equally on the rise. Appliances which were previously little known, such as washing machines, are also enjoying growing success. Summary data illustrating these consumption trends are presented below.

Energy Consumption and the Standard of Living

2.14 Among the above described different factors determining attitudes towards energy use, the 1984 surveys uncovered certain correlations between specific energy consumption and the household's standard of living. Table 2.1, which is based on the results of one of these surveys, illustrates these differences in terms of type of energy consumed and specific consumption for each of the five consumer classes described above.

Table 2.1: SPECIFIC ENERGY CONSUMPTION AND STANDARD OF LIVING IN 1984

Standard of Living *	Wood	Charcoal	Kerosene	LPG	Natural Gas	Electricity	Diesel	Fuel Oil
USING HOUSEHOLDS: (in % of households in mentioned area)								
Rural Area: **								
Level 1 (40%)	81%	40%	89%	38%		16%		
Level 2 (40%)	81%	62%	84%	70%		29%		
Level 3 (17%)	68%	78%	64%	89%		56%		
Urban Area: **								
Level 1 (08%)	35%	77%	83%	63%		58%		
Level 2 (26%)	23%	76%	63%	83%		83%		
Level 3 (32%)	7%	72%	50%	93%	2%	96%		
Level 4 (23%)		35%	41%	89%	5%	99%	2%	
Level 5 (12%)		24%	35%	86%	14%	100%	14%	4%
SPECIFIC CONSUMPTION: (in koe/using household/year)								
Rural Area:								
Level 1	1058	155	164	122		21		
Level 2	756	140	166	130		25		
Level 3	634	166	175	139		47		
Urban Area:								
Level 1	579	116	160	114		18		
Level 2	360	141	177	139		39		
Level 3	353	136	141	159	343	59		
Level 4		92	133	195	399	102		
Level 5		92	250	237	439	173	1334	1029

* For population distribution along the different categories of standard of living, see Annexes 11 and 12. ** Distribution of population: Rural 45%; Urban 55%.

Source: S. Amous and A. Ouerghi, 1986, with consumption numbers adjusted to conversion rates chosen by the mission.

The following observations can be made:

(a) Use of wood and kerosene declines as the standard of living increases. These fuels are associated with poverty, rural lifestyles and/or the past; the consumer switches to other fuels as soon as his purchasing power permits. Use of space heating is limited to the more prosperous urban households.

(b) By contrast, charcoal is used mainly in urban areas, and less is consumed as the standard of living increases. In rural areas, charcoal remains a luxury and is used mainly by wealthier households for a well-anchored Tunisian tradition, the tea preparation.

(c) LPG is the source of energy which has best penetrated the different levels of both urban and rural populations, save the poorest rural dwellers. It is noteworthy that specific consumption of LPG practically doubles among more affluent citizens in relation to the lower levels, probably due to use of water heaters.

(d) Only the wealthiest households have access to natural gas, gas oil and, above all, domestic fuel oil.

(e) Specific consumption of electricity increases very rapidly as the standard of living increases: consumption nearly doubles when rural households at level one are compared to those at level three, and it increases by a factor of ten in urban households when the poorest households are compared with the most affluent.

Household Appliances in Use

2.15 Current information on the equipment rates of household appliances in Tunisian households dates from the 1984 surveys and the information often differs from one survey to another. Average rates at national level were obtained through the Amous/Ouerghi survey and are given in Table 2.2. These figures show that certain appliances already have largely penetrated in the domestic market, such as LPG cookers in more than 70% of households, televisions in nearly 60% and refrigerators in more than 30%. By contrast, other appliances are not yet widely in use, although there is potential for rapidly increasing their level of penetration.

(a) Cookstoves

2.16 Culinary Habits The culinary habits of Tunisian families vary according to socio-economic class. In most cases, two hot meals are prepared daily. The principal and most widely served dish is couscous, which is composed of a basic grain (wheat semolina) and a sauce whose ingredients (vegetables, meat and spices) vary according to the seasons and the household's purchasing power. Preparation requires a special cooker which is very energy efficient. 7/ Bread is also a regular part of every meal. In cities, bakeries have displaced the traditional baking process

7/ Preparation involves a double-boiler type cooker, where the semolina is steamed in a perforated pan which rests on top of the main pot, used to boil water and make the sauce. Thus, much of the energy value of the steam is recovered.

using a domestic oven called a "tabouna", which is still widespread in rural areas. The tabouna is pre-heated, then the bread, formed into little cakes, is put in it and baked in less than 10 minutes.

Table 2.2: HOUSEHOLD APPLIANCE EQUIPMENT OWNERSHIP RATE IN 1984
(National averages)

End-use	Wood a/	Charcoal	Elec. b/	Natural Gas	LPG	Kerosene	Diesel Fuel-Oil
Cooking:							
Cookers and Stoves			2%	73%	27%		
"3 stones"	15%						
Tabouna	54%						
Canoun			48%				
Lighting			63%		8%	37%	
Television			57%				
Refrigerator			32%				
Water heater			5%	1%	7%		
Space heater c/			2%		3%	13%	1%
Air-conditioning			1%				
Washing machine			8%				

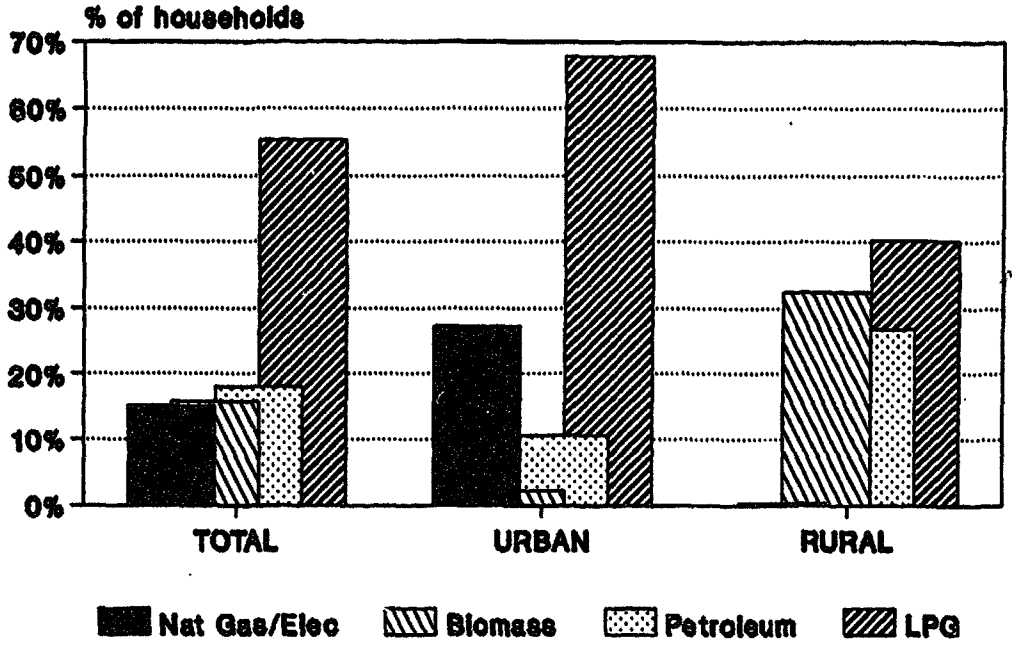
a/Including other biomass; b/Including car batteries (televisions); c/Excluding wood & charcoal.
Source: S. Amous and A. Ouerghi, 1986.

2.17 Cooking Fuels The main cooking fuels are LPG, currently the most consumed fuel (55% of households at national level), and to a lesser extent kerosene and woodfuels, which are used by practically all the remaining households in almost equal proportions (18% and 16%, respectively). Natural gas and electricity are still not commonly used for cooking, even in urban areas. The situation is not uniform throughout the country, however, as indicated by Figure 2, which shows the penetration of principal cooking fuels in Tunisian households according to urban/rural areas and by region. 8/ Thus, even though LPG is the number one fuel in all regions, it remains essentially an urban fuel, as more than half of rural households (59%) continue to use wood or kerosene. Woodfuels have practically disappeared from use in the area surrounding Tunis, but are still a factor in the Central-West, the Northwest, and the Central-East. Finally, natural gas is also an important fuel in areas served by pipeline. Finally, throughout the country, tabouna bread is prepared exclusively with small fuelwood, straw or other biomass.

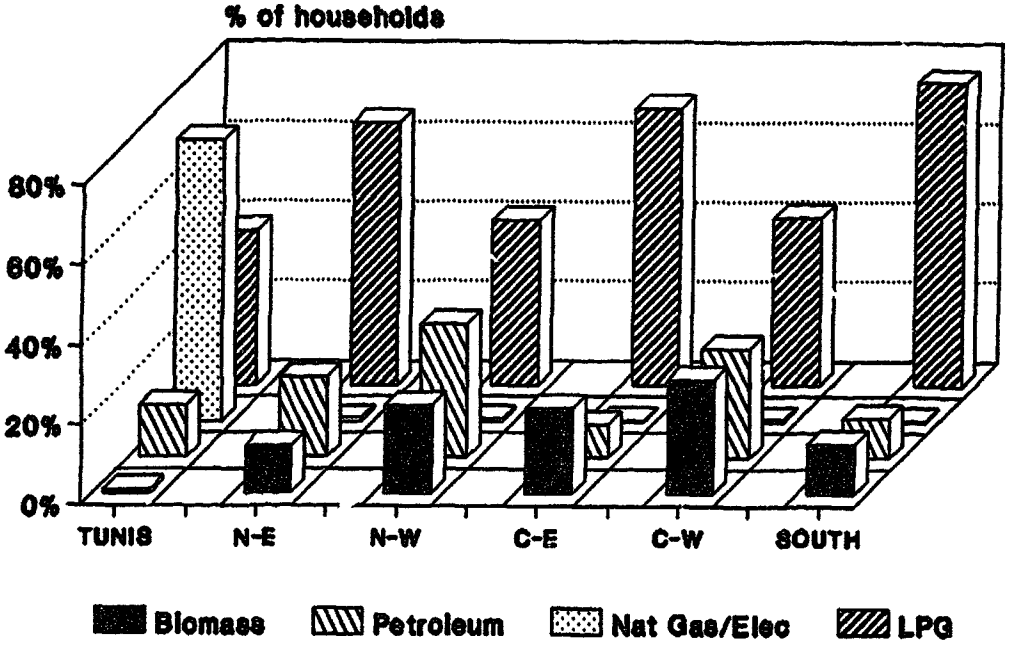
2.18 The results of the survey conducted by the INS in 1989 show a sharp decline in the use of woodfuels and kerosene for cooking, which have been substituted by LPG mainly. Thus, between 1984 and 1989 the percentage of households cooking with kerosene and woodfuels decreased from 17.2% to 8.0%, and 15.2% to 8.6% respectively, while households cooking with LPG (predominant fuel), natural gas and electricity increased from 67.6% to 83.4%. In rural areas the percentage of households cooking with woodfuels and kerosene has dropped to 20.2% and 12.5% respectively in 1989.

8/ The principal fuel is the energy resource most often used in a household which uses more than one energy resource.

Figure 2: COOKING ENERGY SOURCE
By area in 1984



By region in 1984



Source: INS

2.19 Equipment in Use. The gas cookstoves available on the Tunisian market are produced locally by three large manufacturers. According to the results of the Study survey, as presented in Annex 5, this market currently has annual sales of between 80,000 and 100,000 appliances. The market is split between gas ranges, usually equipped with an oven, and hot plates; there are slightly more sales of the latter. The consumer can choose among a large variety of models, with prices ranging from a little more than TD 10 for a gas ring, to more than TD 400 for a deluxe gas range with four burners. The latter are manufactured under foreign (mainly European) licensing agreements.

2.20 By contrast, there are only two types of kerosene stoves offered on the market: the "babour de luxe" and the "babour-économique". Differentiated only by their burners, both are Primus brand pressure stoves which are made locally. There is little difference in the retail prices, respectively TD 13 and TD 12. Since used babours can be bought for TD 7 from small specialized repair shops, it is difficult to ascertain the extent of the market. Disadvantages associated with babour use include: difficulty in lighting and regulating the fire, poor stability, tedious maintenance, and mediocre product quality.

2.21 There are no manufactured fuelwood cookstoves in Tunisia, which may explain in part the bad image associated with this fuel. Households which cook with fuelwood use "three-stone" stoves. This rudimentary solution has a number of disadvantages: poor fuel efficiency, cooking on the floor, bad stability of pots, smoke, etc. By contrast, the wood-fired "tabouna" used for baking bread is composed of a clay sheath made by craftsmen and is similar to ovens (tannurs) found in a number of other countries (Pakistan, Yemen, India).

2.22 With the exception of grilled foods, charcoal is not used for cooking per se, but mainly for preparing Tunisian tea. Different types of charcoal stoves ("canoun") are available, including the widely used clay canoun and the metal canoun, which is found almost exclusively around the city of Sfax. The former sell at prices of 300 to 800 millimes depending on the size; the latter are much more expensive, at 1200 to 1500 millimes. The clay canoun is a simple bowl-shaped pot with no air circulation, which makes ignition difficult and slows combustion, though the latter is desirable in the tea-making process. The metal canoun is more sophisticated: it has a grill and a door which respectively facilitate and control air circulation.

2.23 Thermal Efficiency of Equipment. None of the cookstoves currently in use had been tested for thermal efficiency. Controlled cooking and boiling tests undertaken during the project allow initial comparisons between the different models available on the market as well as models imported or manufactured for the Study (Superior kerosene stove; Ghana improved charcoal stove; multi-pan woodstove). The results of these tests, presented in Table 2.3, are summarized by the following observations:

(a) Since cooking with kerosene is less costly to the consumer, substitution by LPG most likely is governed mainly by the desire to use a more convenient and modern fuel.

(b) Paradoxically, use of fuelwood appears to be the most burdensome, although rural users collect it themselves and it is thus free.

(c) LPG stoves and cookers in Tunisia perform according to European standards, with an efficiency of 50% to 60%.

(d) It is surprising that metal canouns are not used outside the Sfax region, as their performance clearly is superior to that of the clay canoun. The higher price of the metal canoun may partially account for this. It is more likely that the small impact of tea preparation expenditure on total household budget does not lend itself to concern for fuel efficiency.

2.24 The fuel efficiency of the tabouna was also tested. The results show that about 2.2 kg of wood are used for each kilogram of bread produced, which is consistent with specific consumptions measured in the ESMAP/Yemen Arab Republic Household Fuel Marketing Study (2.7 kg/wood/kg of bread for a clay tannur). This corresponds to a consumption of 50 MJ/kg of bread, more than ten times that of the three-stone stove, which measured 4 MJ/kg during the controlled cooking tests. The tabouna thus appears to be very inefficient. It should be noted that charcoal amounting to about 5% of the weight of wood used is recovered at the end of the baking cycle. This tabouna charcoal probably accounts for part of rural charcoal consumption.

2.25 Since the end of this Study's field work, the AME has started field testing of several models of improved stoves for cooking meals or for the preparation of traditional bread, i.e. tabouna and tajine (see a summary of tests results in Annex 19). These tests have been conducted mainly in the Kef region, in the framework of the GTZ supported Special Energy Program (PSE). Several promising products have been identified, including the LPG-fueled Moroccan oven for Tabouna preparation (with an efficiency of 22%), the LPG-fueled aluminium oven for Tajine preparation (efficiency of 27%), the waste-fueled improved traditional Tabouna oven (for which further improvement of efficiency and cost is still needed, however). On the other hand, these tests have shown the very low acceptance of the "Superior" gasoline-fueled stove (for safety reasons) and the lack of prospects for improving the efficiency of traditional wood-fueled "canouns" for Tajine bread preparation.

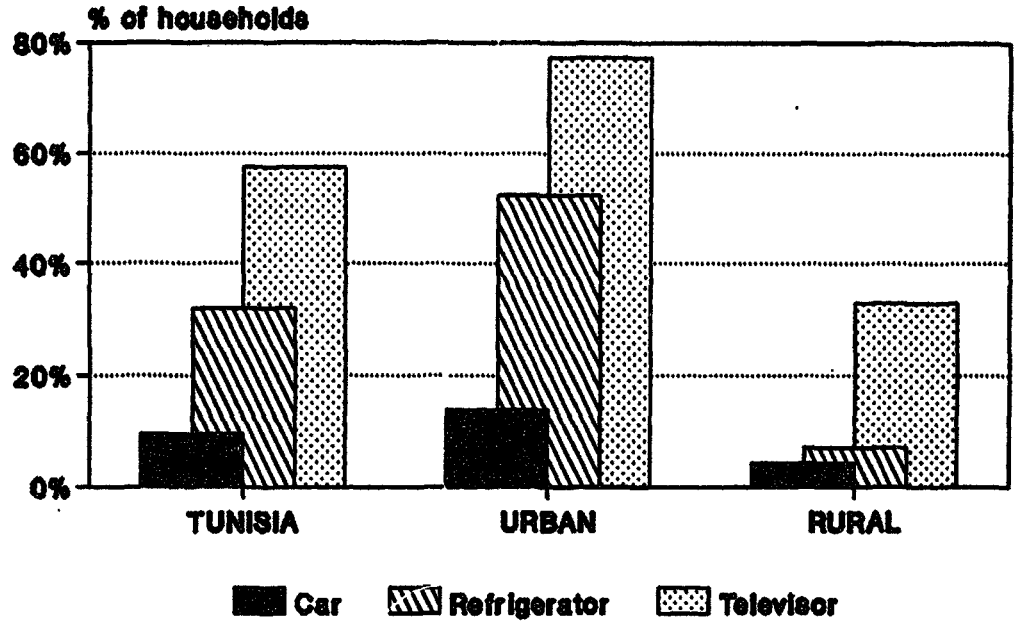
Table 2.3: COOKING EQUIPMENT EFFICIENCY

Equipment	Fuel	Thermal Efficiency a/	Fuel Consumption b/ (kg)	Cost per Standard Meal c/ (millimes)	Cost Equipment (dinars)	Estimated Life span (years)
Cooker	LPG	46 to 55%	0.15 - 0.18	37 to 44	> 170	7
Plate	LPG	46 to 58%	0.12	30	12 to 60	5
Babour	Kerosene	42 to 46%	0.14	28	15	5
3 stone stove	Wood	18 to 21%	1.36	68	free	-
Clay Canoun	Charcoal	9 to 10%	0.76	266	0.3 to 0.8	2
Metallic Canoun	Charcoal	14 to 18%	0.59	206	1.2 to 1.5	2
Superior	Kerosene	46 to 54%	0.15	30	15	5
Ghana model	Charcoal	14 to 18%	0.56	195	2	2
Multipan	Wood	23 to 30%	1.12	56	1.8	1

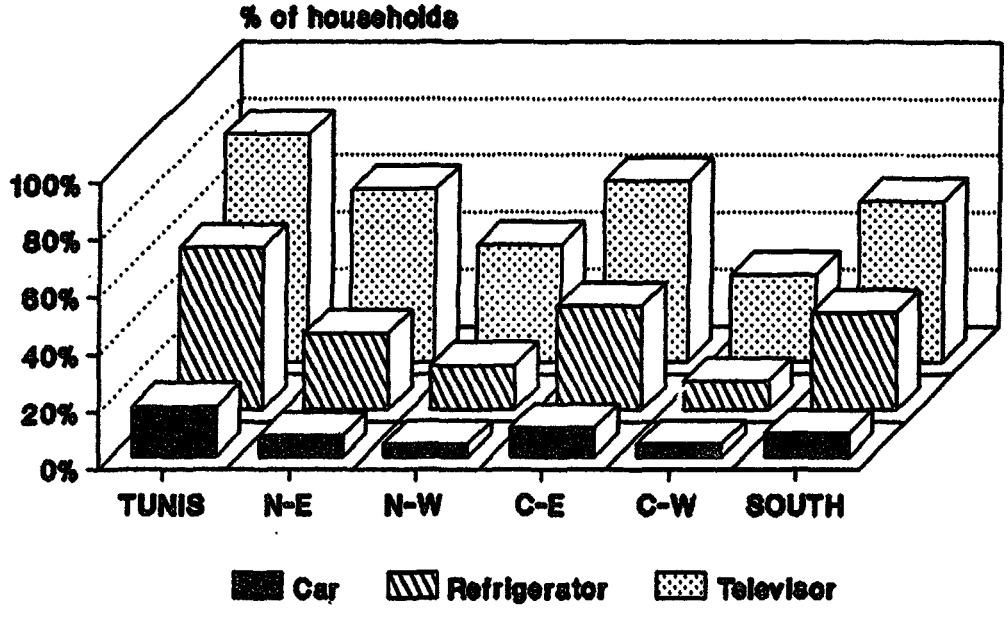
a/ According to boiling test.
b/ Fuel consumption from controlled cooking test for a standard couscous meal (5kg).
c/ Fuel cost per standard meal with following 1989 prices:
LPG = 246/millimes/kg
kerosene = 160 millimes/lt
wood = 50 millimes/kg (urban retail price in the northern part of the country)
charcoal = 350 millimes/kg (Tunis)

Source: Mission tests.

Figure 3: HOUSEHOLD EQUIPMENT
By area in 1984

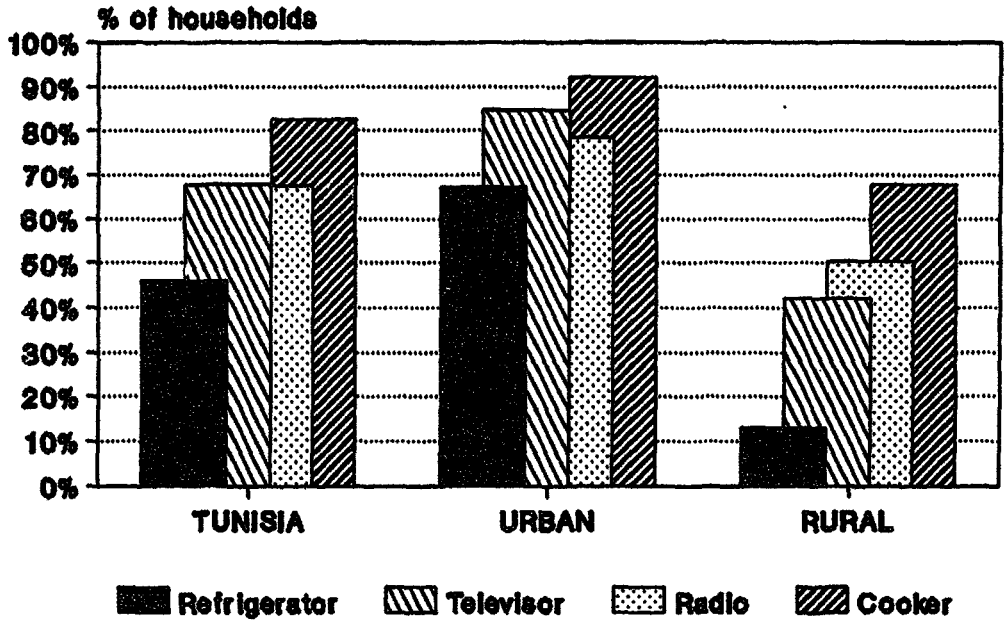


By region in 1984

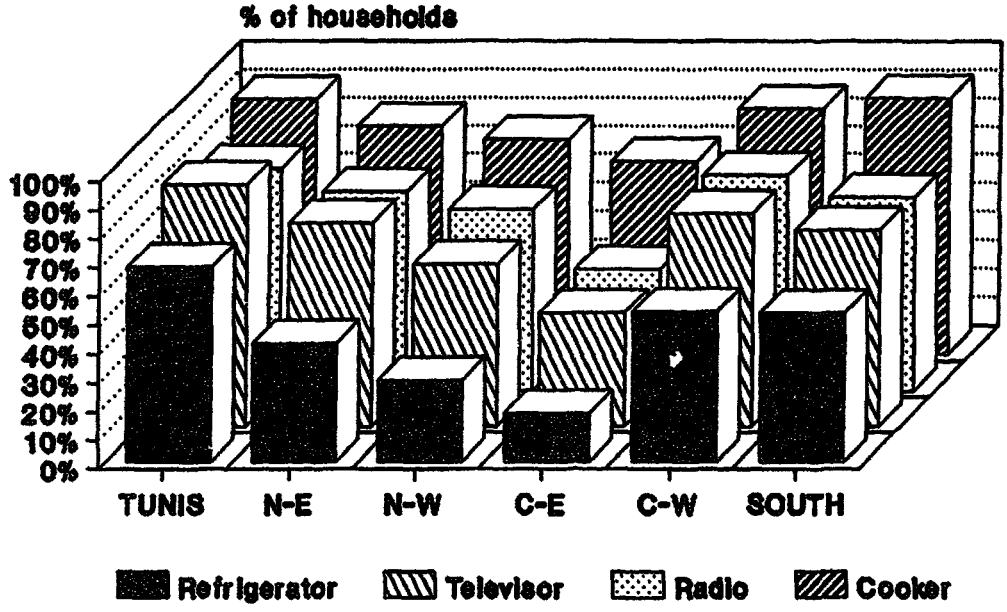


Source: INS

Figure 3b: HOUSEHOLD EQUIPMENT
By area in 1989



By region in 1989



Source: INS

2.26 Costs to the consumers. The results presented in Table 2.3 explain the observed substitution of kerosene with LPG for cooking. When using the cheaper LPG plate, a household has about the same daily expenditure 9/ (32-34 millimes) as when using a kerosene Babour or Superior stove; however, more expensive LPG plates or LPG cookers represent a significantly higher daily expenditure (estimated at 46 and 73 millimes respectively). New retail prices of kerosene and LPG effective since February 1991 do not change the terms of this comparison, since they have increased almost by the same proportion in relation with 1989 (15%). However, if the existing distortion in the price of LPG was removed (see paragraph 3.37), the financial cost of using LPG for cooking, even with the cheaper plate, would be more than 30% higher than the cost of using kerosene.

(b) Electric Appliances

2.27 According to STEG's 1984 survey, lighting accounts for the largest share of household electricity demand (31%), the rest being divided among different electric household appliances. Table 2.2 presents statistics on the average number of appliances per household in 1984, whereas regional and urban/rural variations --often quite substantial for specific appliances--are presented in Figure 3. Both the results of the Study survey of local manufacturers and the sales data shown in Annex 5 give an indication of the number of large appliance purchases in recent years: television sets represent between 40 and 50% of the sales, refrigerators/freezers about 40%, washing machines 10% to 15% and, far behind with less than 5% of sales, water heaters, space heaters and air conditioners. Other electric household appliances (radios and radio-cassette players, washing machines, irons, etc.), which have lower energy requirements, are not examined in this report.

2.28 Lighting is predominantly achieved with incandescent lamps. Results of the 1989 STEG survey show that these lamps represent almost 88% of the total stock for lighting (including lusters), while 12% of the stock are fluorescent tubes. The only local lighting manufacturer produces mainly incandescent bulbs. His operations at present are quite modest and he has been unable to obtain certification of his products in conformity with Tunisian standards. Fluorescent tubes and fluo-compact lamps are imported. The Institut National de la Normalisation et de la Propriété Industrielle (INNORPI) has an ongoing certification program for ballasts of fluorescent tubes including quality and performance.

2.29 According to the INS, the market for television sets increased by about 10% p.a. between 1980 and 1984. The latter year saw record sales of 125,000 sets; since then, the market has been in slight recession, probably due to market saturation. The market today probably is between 50,000 and 70,000 sets per year (Annex 5), furnished exclusively by local production. European, South Korean and other foreign brand models are assembled under licensing agreements. The average power requirements of televisions sold on the market is 80 W.

2.30 The market for refrigerators and freezers also grew at a strong rate of 14% p.a. between 1980 and 1984; according to the results of the 1989 STEG survey this rate has even increased to almost 18% p.a. on the period 1984-1989. At present, the annual market is estimated at 50,000 to 60,000 appliances (primarily refrigerators). There are very few imports, as these are

9/ With a linear depreciation of equipment cost, two meals per day and 1989 fuel and equipment prices.

subject to extremely high customs duties. Locally manufactured appliances are assembled from locally-made and imported parts: the former include sheet metal, paints, molds for the outer doors and bins; the latter mainly motors and compressors. Different brands are distributed under foreign (mainly Italian) licensing agreements. The least expensive models, which cost TD 350 to TD 400, already are priced quite high in comparison with average purchasing power. However, most models sell for around TD 800. Uniform standards have been adopted for refrigerators, and a certification process is underway for the principal manufacturers. 10/

2.31 The market for washing machines has developed quite rapidly, with sales doubling in three years. Today, the annual market amounts to between 20,000 and 25,000 machines, three-quarters of which have small load capacities (less than 2.5 kg). The market is equally divided between imported and locally manufactured models. A certification program is underway.

2.32 Performance. Television sets, refrigerators/freezers and washing machines are manufactured locally using the same parts and conforming to the same standards as those in the countries which grant the licensing agreements. Quality control also is based closely on the controls exercised in the licensors' factories. Power requirements and average electricity consumption are identical to those required for European models. Thus, it can be assumed that the level of quality maintained to date is due primarily to the fact that the appliances are exact replicas of those currently manufactured in Europe, right down to quality checks required by the licensor.

(c) Water Heaters

2.33 According to the 1984 surveys, only a small number of households have water heating (less than 15%, see Table 2.1), mainly urban households. Other households use their cookstoves to heat water. Between 15,000 and 20,000 gas water heaters, the most widely used type of appliance, are purchased annually. Almost all of these are manufactured in Tunisia. The basic model, a 10 l/mn gas heater which consumes 1.5 kg of gas per hour and heats water to 65°C, costs TD 200, with an additional installation fee ranging from TD 30 to TD 40. Average consumption, based on one to two hours use daily, is equivalent to one 13-kg bottle of LPG each month; a bottle costs TD 3.5. There are no uniform safety standards for gas water heater technology, so technical quality varies. However, the technologies used generally are those approved in European countries with the strictest standards. Therefore, safety and energy efficiency often are superior to imports not belonging in "major brands".

2.34 The current market for electric water heaters shows no tendency for growth. In fact, the annual sales have stagnated at less than 5,000 heaters, mostly of local manufacture. This is due in part to recent changes in STEG's policy. Initially, STEG provided tariff incentives for use of electric water heaters; STEG has dropped these benefits, and now favors the use of solar water heaters with electric backup.

2.35 Currently, 7,000 solar water heaters with electric backup are in use, with construction of about 7,000 m^2 of new units each year. The market is not very developed, due mainly to the

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9/ Implementation of certification procedures has been delayed until INNORPI has facilities to perform its own trial tests for refrigerators; these were scheduled for installation in 1990.

relatively high price of equipment and installation. As a result, the impact of solar water heaters on peak electricity load in winter remains limited and has not yet been measured. Concerning regulatory aspects, the INNORPI has drawn up uniform standards for solar water heaters.

(d) Heating and Air Conditioning

2.36 About 20,000 to 30,000 space heaters are sold annually. Kerosene and natural gas radiators are the most commonly purchased heaters, with about 35% of the market respectively. Wall heaters and radiators fueled by LPG and fuel oil radiators represent the next largest market shares. Most of these different appliances are manufactured locally. Some models are imported (fueled principally by natural gas and LPG), but these might not offer the same guarantees of performance and quality as locally produced models. Electric space heating is little developed. There are no uniform standards at present for space heaters. Finally, central heating is not yet commonly used.

2.37 Air conditioning is not often found in homes. The annual market of less than 3000 air conditioning units is divided fairly evenly between single wall/window units and split systems. Most air conditioners are manufactured locally under a licensing agreement with an Italian firm. There is no mechanism for ensuring that the appliances have acceptable levels of energy efficiency. There are also some imports. At present, there are no uniform standards for air conditioning units.

The Tertiary Sector

2.38 Energy demand in the tertiary sector is even less known than that of the residential sector. This is partially because the tertiary sector is rather heterogeneous in terms of economic activities, energy uses, and types of building uses. Data from the only survey of the tertiary sector, initiated by the MEN in 1985, 11/ is not very representative, as survey samples were too small.

2.39 It is difficult to gather accurate data for the sector. Energy producers and distributors do not systematically keep records which correspond with the consumer categories in the tertiary sector. Statistics concerning buildings and, more generally, concerning factors affecting energy demand (surface areas, volumes, existing building stock by category, existing heating and air conditioning equipment, etc.) are dispersed. Published INS statistics furnish some elements, such as number of nights in hotels, school enrollments and teacher populations, and the capacity of hospitals with more than 100 beds. Statistics on newly constructed buildings are available from construction permits filed at the municipal level. Unfortunately, they are not centralized and therefore there is no information on construction rates of new buildings. Information is most scarce for office buildings, commercial establishments and private sector services.

2.40 Analysis of the structure of demand is based on the limited number of audits performed to date and on additional data resulting from a survey of Moorish baths and restaurants

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11/ "Chiffres et analyses de la consommation d'énergie des bâtiments du secteur tertiaire," Lindsay, Bahri and Meddeb, January 1985.

carried out during the Study. The energy demand balance for the sector, excluding woodfuels, is presented in Table 2.4. The table shows (a) the dominance of gas oil and electricity in the breakdown by type of energy (b) the prominence of the hotel/restaurant industry, which represents nearly 40% of the total demand, and (c) the importance of Moorish baths, second largest consumer in the sector (especially when estimated wood consumption is accounted for).

Structure of Demand

2.41 The principal energy sources used in the tertiary sector, excluding woodfuels, are gas oil and domestic fuel oil (nearly 50% of final demand), electricity (one-third) and natural gas (10%). Other fuels are consumed in smaller quantities: LPG used in the hotel/restaurant industry for cooking, kerosene used in Moorish baths for water heating instead of or in addition to gas oil, and heavy fuel oil used for large furnaces in some major establishments.

2.42 Gas oil generally is consumed in buildings which are occupied continuously (such as hotels and hospitals), mainly for space and water heating, as well as in Moorish baths, which absorb about 30% of the total demand. However, over the past few years, natural gas has substituted gas oil in a number of establishments (particularly hotels) in the Tunis region and in tourist areas along the coast. The present gas grid reaches Tunis, Nabeul, Hammamet, and Sousse. An estimated 90% of large hotels have been converted to gas; sales in the sector have reached 22 million m³. Gas is also used in these establishments for cooking.

Table 2.4: FINAL ENERGY CONSUMPTION IN THE TERTIARY SECTOR (1987)
(in thousands of TOE)

	Natural gas	LPG	Kerosene	Diesel & Fuel Oil	S/total pet prod.		Electricity		TOTAL	
Hotels	15.5	1.6		33.2	50.3	39%	13.2	21%	63.5	33%
Restaurants, cafes	1.3	6.3			7.6	6%	1.7	3%	9.3	5%
Turkish baths *	0.2		7.6	24.8	32.7	25%	0.2	0%	32.9	17%
Public health	1.5	2.0		11.0	14.5	11%	3.5	6%	18.0	9%
Administrations	0.2	0.1		4.0	4.3	3%	4.3	7%	8.6	5%
Public lighting							3.8	6%	3.8	2%
Others	0.2	3.1	0.2	16.0	19.5	15%	35.3	57%	54.8	29%
TOTAL	18.9	13.1	7.8	89.1	128.9	100%	62.0	100%	190.9	100%
	10%	7%	4%	47%	68%		32%		100%	

Source: ONTT, STEG, DURE/AME, Ministry of Public Health.
AME surveys and mission estimates excluding woodfuels.
* Wood consumption estimated at 17,355 TOE in 1987.

2.43 Electricity is the most commonly consumed energy in several subsectors: commerce, offices, schools, miscellaneous services. Electricity consumption is also intensive in hotels and hospitals, although less so than that of gas oil. A large part of the total electricity demand of the

tertiary sector is accounted for by categories not listed in Table 2.6 (57% of the total, representing 35300 toe in 1987) such as offices, retail stores and miscellaneous services. Demand is split exactly into two-thirds high and medium voltage (370 GWh in 1987) and one-third low voltage (185 GWh). The tertiary sector's contribution to peak load probably is more than its share of power demand. In effect, electricity consumption is not divided uniformly over time because buildings in the sector are occupied only during specific periods of the day. Also, air conditioning is used only during the hottest hours of the day. In 1989, the STEG started analyzing the load curves for the sector as an input for determining the requirements for additional generating capacity.

2.44 Overall consumption of specific electricity uses (lighting, air conditioning, motors and engines, miscellaneous appliances) represent a minor portion of the total energy demand in the tertiary sector (about 30%). According to the 1985 MFN study, electric power is used mainly for lighting (more than half the total consumption), followed by air conditioning (less than 20%) and miscellaneous uses. Lighting and miscellaneous non-heating applications dominate in commerce, schools, and the public/private service sectors (social, cultural, recreational). Use of air conditioning is especially well-developed in office buildings and the hotel industry, where corresponding electricity consumption can exceed that for lighting.

Hotels and Restaurants

2.45 For a long time, Tunisia has devoted significant resources to developing its tourist industry. Over the past five years, the value added of hotels and restaurants (including bars and cafes) has risen at an average annual rate of about 11%. This industry's contribution to tertiary sector GDP and to the national GDP also have risen, totalling approximately 11% and 6% respectively in 1988.

2.46 In 1988, there were more than 430 hotels, family guest houses and vacation villages, with a total capacity of more than 100,000 beds. About 30% of these are large scale, deluxe accommodations (3 or 4 stars) comprising nearly half the capacity. The occupancy rate averages only 50%, due to the seasonal nature of the tourist industry. To date, energy audits have been performed on a dozen establishments. The data thus obtained were used to estimate final energy consumption in hotels, which is presented in Annex 6. In summary, the data indicate that:

(a) the 120 deluxe establishments absorb nearly 70% of all energy consumed by hotels;

(b) the predominance of gas oil, domestic fuel oil and natural gas consumption--representing more than three-quarters of total consumption--emphasizes the importance of heating (buildings, sanitary hot water, pools) in the subsector;

(c) although electricity only ranks third among fuels consumed, it represents nearly 30% of energy consumption in deluxe hotels, mainly because of air conditioning.

2.47 With the exception of tourist restaurants affiliated with the Tunisian National Office of Tourism (ONTT), there are no precise statistics concerning the number of restaurants and cafe/bars. An estimate of this number was made using ONTT and INS statistics and served as the basis for the statistical sample used during the survey carried out in the Study. The survey covered 232 establishments (comprising more than 5% of the estimated employees) spread across the country. The results were used in preparing a preliminary final energy demand balance for the

restaurant industry, which is presented in Annex 7. The balance shows that:

(a) The subsector consumes less than 10,000 TOE/yr, equivalent to 15% of final energy consumption by hotels and 5% of the total for the entire tertiary sector (excluding woodfuels).

(b) Consumption of LPG, used for cooking and preparing hot beverages (coffee and tea), exceeds by far that of other fuels, and represents 70% of the final consumption.

(c) Natural gas has been substituted for LPG in tourist restaurants, most of which are in areas where natural gas is distributed: more than two-thirds of these establishments use natural gas.

(d) Electricity accounts for less than 20% of final consumption of the subsector; this is about the same percentage found in hotels.

Turkish Baths

2.48 Regular visits to Turkish baths is commonplace in Tunisia, both for health and religious reasons. 12/ There are no precise statistics on the number of Turkish baths, which has been estimated at about one thousand establishments in operation, based on figures obtained from municipalities and the Tunisian Union of Industry, Commerce and Craftsmen (UTICA) and from a poll of twenty rural clusters. The main survey conducted during the Study used a sample of fifty Turkish baths in urban areas (encompassing more than 5% of the total number of urban establishments) and 21 establishments in rural areas.

2.49 The final energy demand balance for Turkish baths established on the basis of these surveys is given in Annex 8. The principal observations are:

(a) In towns with more than 2,000 inhabitants - where about 87% of all establishments are located - about two-thirds of the establishments use gas oil (65%). Gas oil consumption represents nearly half the final energy consumption, including woodfuels.

(b) Almost all establishments located in small rural towns (less than 2,000 inhabitants) use wood exclusively, as do about 13% of the other establishments. Some baths use both wood and gas oil or kerosene. Overall, wood accounts for more than one-third of the total consumption of final energy.

(c) Kerosene is used exclusively by more than 20% of establishments in towns with more than 10,000 inhabitants, but the percentage declines in the smallest towns. Nevertheless, this fuel represents about 15% of the total energy consumed.

12/ According to the INS, less than 15% of Tunisian dwellings had bath or shower facilities in 1984; the percentage of urban dwellings with these facilities tallied 23%, as compared to only 1% of rural dwellings.

(d) There have been few conversions to natural gas, and electricity consumption--mostly for lighting--is modest. Each accounts for less than 1% of the total.

2.50 The survey also revealed that the average energy expenditure of a Turkish bath located in the larger towns is about TD 13,500 per year. Using the entrance fee--approximately 500 to 600 millimes--as the base for calculation, nearly 25,000 customers would be needed to cover annual energy expenditures. This figure corresponds roughly to the average number of patrons reported in the survey. Thus, even though each customer generally spends more than the entrance fee (often twice as much), and the customer estimates were probably less than the actual numbers, clearly energy expenditures represent a large percentage (perhaps 30% to 50%) of revenues.

Energy Supply

Woodfuels

Forestry Resources

2.51 Tunisia's natural forest formations are mainly composed of oak or pine forests and shrub-covered savannah or steppes ("garrigues"); the type of forest cover varies according to the different climatic zones. In addition to natural vegetation, there are a number of national or private forest plantations composed mainly of pines, eucalyptus and/or acacias, as well as large surface areas planted with fruit trees.

2.52 There is no recent and detailed inventory of forest resources. The only data available cover state lands managed by the Directorate of Forestry Resources (DGF) in the Ministry of agriculture (MA), which represent 3.3 million hectares (ha), or about 20% of the national territory. State forests occupy only one-quarter of this area, or about 900,000 ha. They include natural forest, reforested zones, and stretches of dense undergrowth (maquis) and garrigue. The main national forests are located in the Northwest region--where there are still large forests of oaks (cork oaks and zeen oaks)--and in the Central West region. Many of these so-called "forests" can be quite degraded 13/. The rest of the territory controlled by the DGF are composed of grazing zones and state farms (1.88 million ha), and shrub-covered zones (520,000 ha). The grazing zones are located principally in the semi-arid regions of the Southwest and the Southeast, but some also exist in the dry mountains of the Central West and the Sahel.

2.53 According to MA figures, fruit trees occupy more than 2 million ha in Tunisia, almost double the state forest cover. The most common are olive trees (1.4 million ha) and almond trees, followed by orange, peach and plum trees. The Olive Tree Institute estimates that there are currently about 55 million olive trees: 20 million in the north, 20 million in the central regions (particularly in the Sahel) and 15 million in the south. Planting densities vary from 100 trees per ha in the north to 20 trees per ha in the south.

13/ Since most existing data date from 1984 or earlier, it is probable that degradation of forest resources has increased to date due to the severe drought which occured between 1984 and 1987.

Availability of Wood for Fuel

2.54 The total availability of wood for fuel cannot be estimated precisely, as there have been no inventories of Tunisia's natural forests. In particular, it is impossible to determine whether forest productivity presently is sufficient to cover demand for woodfuels, and whether it will be insufficient in the future. However, the Forestry Development Project (FDP), carried out by the DGF with World Bank financing, should improve the quality of data on national forests.

2.55 The quantity of wood available from olive trees can be estimated from data provided by the Olive Tree Institute. 14/ Olive trees must be trimmed regularly, and the quantity of wood obtained from trimming varies by region and the age of the tree. 15/ Fruit trees are trimmed biennially; the average yield for all of Tunisia is estimated at 15 kg of wood per tree per year: this is equivalent to about 825,000 tons of olive wood per year. This estimate is quite conservative and includes neither output from replacement cuts of older trees, nor leaves and twigs, which are generally used as fodder for animals or burned in the fields. When wood from maintenance trims of other fruit trees is added to this production, the total availability probably rises to more than 1 million tons each year. This is undoubtedly one of the major supply sources for wood for fuel.

Regulations and Enforcement

2.56 In theory, a cutting permit is required to fell any tree in Tunisia. The permits can be obtained at the Governorate level. Exceptions include fruit trees other than olive trees, and maintenance trimmings. Wood from national forests is marketed by the DGF mainly by auction of standing stock. About 120,000 tons of wood were sold by auction in 1988, of which nearly three-quarters (90,000 tons) were standing stock. In certain areas--mainly in the Central West and the Northwest--the DGF allows the neighboring population to supply itself with wood free of charge according to the practice of "users' domain", the terms of which vary from one Governorate to another. The DGF estimated that in 1987, wood cut under such practices accounted for some 500,000 tons.

2.57 Field agents from the forestry service monitor forest production, but regulations are only partly enforced. Peasants in agricultural zones usually do not bother to apply for cutting permits, even when they are sure to get one with no difficulty. The DGF suspects this is also the case in forest zones, where there has been considerable fraudulent cutting which does not fall under category of the users' domain.

2.58 Charcoal production is also subject legally to prior authorization. Carbonization permits are granted by the forestry service in the Governorate, but only if the applicant can prove that the wood was cut legally. Permits are valid only for a limited time (usually up to 14 days) so that they cannot be re-used. Both forestry agents and police are empowered to enforce the permits. In 1988, legal charcoal production was about 37,000 tons, or 185,000 tons of wood equivalent.

14/ "Les sous-produits de l'olivier", Ali Nefzaoui and M'NaouerZidani, Publication of the Olive Tree Institute, Sfax.

15/ For example, fruit tree trimmings from young plants produce about 30 kg/tree/year in the north, while those taken from mature plants reach 70 kg in the south, while replacement cuts of aging plants produce 100 kg/tree in the north and 425 kg/tree in south.

2.59 Fuelwood and charcoal can only be transported with a transport permit ("permis de colportage"). The forestry service within the Governorate grants the transport permit upon presentation of a cutting permit or a carbonization permit, and after verifying the stocks in the applicant's depots. Transports permits are valid only for the day it is granted and during certain hours (to avoid fraud). Enforcement is carried out by the forestry agents and the police. It should be noted that the transport permits are granted on the basis of the vehicle's nominal useful load. However, in practice, transporters systematically overload their vehicles. As a result, the quantities registered on the permits probably underestimate the actual load by 20% to 30%.

Production and Distribution Networks

2.60 Fuelwood. Fuelwood is commercialized in only a few rural areas as well as in urban areas, where, however, its consumption is very limited. The DGF is the largest supplier of wood and sells directly to the consumers. The only commercial distribution route is found in the Northeast, where merchants buy wood from the DGF or private wholesalers and resell it in the towns of the mountain regions, mainly for heating. In other regions of the country, the rural population collects wood for its own needs. In the cities, wood is rarely used except in preparation of tabouna bread. It often is purchased from various sources, none of which constitute a really structured distribution network.

2.61 Charcoal. Likewise, the majority of charcoal consumed by rural dwellers does not come from commercial sources, it is produced by the user. By contrast, there are well developed supply networks for production, distribution and marketing in cities. The networks are different, depending on whether forest wood or olive tree wood is used to produce charcoal. For the former, wood is purchased by buyers at the DGF, most often in the form of parcels of standing trees. Olive tree trimmings are purchased already cut, directly from the peasants.

2.62 The wood is then carbonized by professionals on the exploitation site, if the wood is from forestry production, or at permanent production sites (when olive tree trimmings are used). The charcoal producers are usually paid according to the weight of charcoal produced, but at the work sites, some have fixed salaries. They work in teams of two to five persons. Usually, the wood is air-dried as much as possible, then carbonized in an earth kiln. The kilns vary in production capacity from 750-800 kg of charcoal up to 10 tons; the most commonly used kilns produce about 2.5 tons per batch. According to available data, observations and tests carried out during the Project, professional charcoal producers have perfected the earth kiln technique, thus resulting in relatively high yields: weight yields often exceed 25% for olive tree wood and 20% for other wood, according to DGF estimates. 16/ (see Annex 17)

2.63 The charcoal is packaged in 30 to 50 kg bags for transport to cities using small pick-ups or standard trucks. Most merchants have their own vehicles, but they also sell charcoal along the roadside to transporters. Once in the city, the truck is unloaded at a wholesale depot managed by the merchant, the transporter, or a third party. There are 20 to 25 depots of this sort in Tunis. From the depot, charcoal is sold to wholesalers or retailers or directly to consumers.

16/ In this report, the figure of 20% by weight was adopted as the assumption for average carbonization efficiency at national level; this takes into account the fact that rural self-producers are probably not able to reach carbonization yields of professional charcoalers.

Price Structure

2.64 The price structures for fuelwood and charcoal presented in Table 2.5 are based on preliminary information gathered during the project. They are representative only of particular cases; indeed the producer prices (ex-DGF or ex-peasant), carbonization and transport costs, margins and the retail prices vary from city to city and from region to region. However, the review of these structures underscores the size of the distribution margins (often on the order of 50%), which provide substantial benefits to the merchants.

Table 2.5: WOOD PRICE (in D/ton)

	Commercial Supply				Local Use	
	Cord wood		Bundle		Cord wood	Bundle
DGF sale price	11	29%	8	13%	6	4
Margins a/	29	71%	52	87%		
Urban retail price (North)	40	100%	60	100%		
i.e. in D/TOE	118		176			

a/ Including cost of transport from production zone to town and handling cost.

CHARCOAL PRICE (in D/ton)

Zone	North-Tunis		Sahel-Sousse	
Wood origin	Natural Forest		Fruit Tree Pruning	
Stumpage value	40			
Production cost	50			
Producer gate price	90	26%	90	28%
Charcoaling cost	50	14%	50	16%
Transport a/	32	9%	10	3%
Handling costs b/	8	2%	8	3%
Distribution margins c/	170	49%	162	51%
Retail price	350	100%	320	100%
i.e., in D/TOE	441		403	

a/ On the base of 135 km for Tunis and 80 km for Sousse pick-up load = 1.2 ton of charcoal.
b/ Loading/unloading at the depot or retail point.
c/ Wholesaler and retailer.

Source: Mission estimates and DGF.

2.65 It is impossible to estimate the economic cost of standing wood and to compare it to DGF's producer price, as there is no information either concerning the costs of managing and maintaining national forests, or on the costs of wood plantations. The case of olive tree wood is simpler: as a by-product of maintenance trims, which are necessary to enhance the tree's production, its stumpage value is zero and therefore its exploitation is interesting. The problem then becomes how to choose among different possibilities for exploitation techniques. The PDF is currently studying the question.

Hydrocarbons

Natural Gas

2.66 Manufactured gas ("city gas") has been in use in Tunisia since the last century, long before the development of natural gas. Until 1955, coal was used to manufacture the gas; between 1955 and 1971, natural gas from the small Djebel Abderrahman field at Cap Bon 17/ and then, until 1983, light gasoline were used. Since 1984, city gas has been manufactured using natural gas from Algeria. City gas is distributed in Tunis; maximum production was reached in 1985 with 0.14 million TOE. A conversion project affecting the distribution network and household installations has been underway since then so that city gas can gradually be replaced by natural gas.

2.67 Natural gas consumed in Tunisia comes from two main sources other than the gas field at Cap Bon: the El Borma field and the Trans-Mediterranean Pipeline (TMP) linking Algeria with Italy. Recovery of associated gas at El Borma began in 1972. Since 1978, natural gas from the Algerian section of the field also has been purchased. Gas production at El Borma grew at a regular pace until 1982, when it reached 0.55 million TOE, then remained practically constant till 1987, when it started declining. Cumulative production between 1972 and 1988 was approximately 8 million TOE. Gas is transported by pipeline from El Borma towards Gabès (300 km), where it is used in part by several large companies in the industrial zone. Since 1987, natural gas also has been used as feedstock in a gas plant at Gabès to produce LPG and gasoline.

2.68 The TMP was placed in service in 1983. By 1985, it was already a major source of natural gas for Tunisia, supplying 60% of the Tunisian market; the share has continued to increase. Tunisia has access to the following quantities of natural gas from the TMP: (i) about 35% of the total to reimburse transit rights (royalty gas) and (ii) about 65% of deliveries through direct purchases from Algeria. All or part of the royalty gas can be taken in kind or in cash. Between 1983 and 1986, only two-thirds of the royalty was taken in kind. Natural gas imports from Algeria thus include offtake from the Algerian section of El Borma and purchases from the pipeline. These imports represented between 20% and 25% of total supply to Tunisia in 1984 and 1985, compared to less than 10% in 1983.

2.69 STEG holds the monopoly for natural gas distribution in Tunisia. STEG purchases gas from SITEP, which operates the El Borma field, and from ETAP, which imports the Algerian

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17/ This was the first natural gas field developed in Tunisia and was put into production in 1954. Cumulative production reached 0.17 million TOE by the end of 1987.

gas. In addition, STEG itself operates the small field at Cap Bon and owns the gas plants near Gabès and in Tunis (El Omrane, where city gas is manufactured). Currently, the distribution network served by the pipeline includes the areas of Tunis, Sousse, Monastir, Kasserine, Tajerouine and Korba.

LPG

2.70 Supply. Since 1987, LPG consumed in Tunisia has come from three sources: (a) the STIR refinery at Bizerte, with current LPG production capacity of 30,000 tons/yr; (b) the gas plant at Gabès, which has recovered LPG from El Borma associated gas since March 1987, with production exceeding 50,000 tons in 1988; and (c) imports handled by ETAP, totalling about 116,000 tons in 1988, or nearly 57% of national demand. Before the plant at Gabès was commissioned, more than 80% of the supply had to be imported; total imports were as high as 147,000 tons in 1986.

2.71 Although current LPG imports have dropped to the same levels as a decade ago, they are nearly quadruple the 1976 level (30,000 tons), representing an annual average growth of 12%. 18/ LPG imports come from different Mediterranean ports (Algeria, Italy, Greece, France) and enter Tunisia through its ports at Bizerte, La Goulette (Tunis), Sfax and Gabès. The fuel is imported in average-sized cargoes, which generally vary from 700 to 1700 tons. In 1988, cargoes were imported at a rate of six per month, but sometimes increased to as many as eight at La Goulette and Sfax, causing congestion and long waits at the port.

2.72 Storage and Bottle Refills LPG is distributed to the domestic market by four distribution companies (distributors): SNDP, a national company, and the private companies BUTAGAZ, PROMOGAZ (both subsidiaries of SHELL-Tunisia) and TOTAL GAZ. Transport from ports and from the refinery to the distributors' depots is by pipeline. Part of STIR's production (about 20%) is delivered in bulk by truck directly to large customers.

2.73 The legal framework governing LPG stocks requires that STIR and each of the distributors keep security stocks equivalent to one months' sales and working stocks of 15 days'sales. Storage requirements are calculated based on averages from the preceding year. STIR currently has 6,000 tons of storage capacity, and the distribution companies have a total of 15,000 tons. The latter are scattered unevenly throughout the country, with 6,700 tons (45%) in the north (depots at Bizerte and Tunis), 1,170 tons (8%) in the central regions (depots at Sfax) and 7,100 tons (47%) in the south (depots at Gabès). Based on the review of regional sales in 1988 and according to DGF estimates, about 5,000 tons of additional storage capacity is needed, especially in the north and central regions of the country. Estimates of future storage deficits are presented below.

2.74 A very small quantity of LPG is distributed in bulk, but most is bottled in quantities of 3 kg, 5 kg, 25 kg, 35 kg and 13 kg, the latter representing around 90% of consumption 19/. The existing refill capacity for the entire country is 6,400-13 kg bottles per hour. This includes five

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18/ The average growth rate between 1976 and 1986, when the Gabès plant came online, exceeded 17% p.a.

19/ However, since 1989 the distributors have tried to increase their sales of 3 and 5 kg bottles in the rural and peri-urban market.

refilling stations at the distribution depots, 20/ two of which are owned by SNDP and three operated by companies (NORD GAZ and SUD GAZ) owned jointly by the other distributors. Based on operations of 10 hours/day and 25 days/month, the five stations have refilling capacity of 1.6 million-13 kg bottles per month, which is sufficient to cover LPG demand during peak (1.4 million/month) and off-peak (1.2 million/month) periods.

2.75 An estimated 2.4 million-13 kg bottles are in use in 1987. The discard rate for that same year was 3.5%. Given this rate, a rotation of bottles estimated at 5.5 refills per year and an annual consumption growth of 4%, the current demand for new bottles should be about 200,000. This demand can be met amply by two existing manufacturers, whose total capacity is 330,000-13 kg bottles per year. The ex-factory price of a 13 kg bottle has risen successively from TD 18/unit in 1986 to TD 26 in 1987, then to TD 30 in 1989, an increase of 70% in three years. This price has discouraged distributors from purchasing new bottles, despite wear and tear on their inventory. (See price structure in Table 2.6).

2.76 Distribution SNDP owns nearly 40% of the storage capacity and 46% of the refilling capacity in the country. In 1987, it also held nearly half (49%) of the internal LPG market, with the other half split among the private distribution companies. 21/ Private intermediaries--called dépositaires, or shipping agents--distribute the bottled LPG to retailers, using their own vehicles, storage depots, working stocks of empty bottles and hoisting equipment.

2.73 About 140 shipping agents are also sub-contractors for the distributors. However, since their margin is nominal (200 millimes/13 kg bottle), shipping agents try to increase their profits by limiting the distance travelled and by giving priority to deliveries to large retailers and to the coastal areas near the refilling centers. As a result, small retailers and outlying refilling stations have supply difficulties. It is not uncommon in rural areas for the consumers themselves to travel long distances to replace empty bottles: in this case, they must pay the extra cost of their own transport. Also, bottles are not interchangeable--SNDP bottles are different from those used by the private distributors--which further complicates supply to the consumer.

2.74 Although shipping agents supply more than 9,300 sales points across the country, shortages are common in some distant rural areas. Sales permits for LPG are granted by the Direction de l'Environnement of the Ministry of Commerce; the DGE is not involved in the process. For safety reasons, the Direction de l'Environnement requires that the retailers keep no more than 20-13 kg bottles in storage. This regulation, which would lead to disruptions in the stock, is rarely respected.

20/ The two stations are located in the north (Bizerte and La Goulette) have a total capacity of 3,250-13 kg bottles per hour; the central station (Sfax) can fill 1200-13 kg bottles per hour; and the two southern stations (Gabès) have a total capacity of 1950-13 kg bottles per hour.

21/ BUTAGAZ - 24%; PROMOGAZ - 19%; and TOTAL GAZ - 8%.

Kerosene

2.75 Supply and Storage. All of STIR's kerosene output goes to the production of "pétrole lampant", 22/ or regular kerosene, whereas aviation kerosene is imported. To date Tunisia has been self-sufficient in kerosene, with the exception of a few years (such as 1984 and 1985, recently) when imports were needed to complement local production; no more than 16% of supply has ever been imported (in 1985), however. STIR's kerosene production has risen from 64,000 TOE in 1972 to top 159,000 TOE in 1987, an annual average increase of more than 6%.

2.76 The legal framework governing stocks requires that the refinery and the distributors hold one and two months' security stocks respectively, 15 days' working stocks (based on current sales) and a 95% refill coefficient. STIR's storage capacity at Bizerte is about 18,000 m^3, which, in 1988, represented a surplus capacity of about 3000 m^3 compared with storage requirements. The distributors have 41,080 m^3 in storage capacity divided between SNDP (3357 m^3) and the private companies, for a surplus of about 2000 m^3 relative to their combined 1988 storage requirements. (Taken alone, however, SNDP has a slight shortage of capacity.) The distributors' main depots are located at La Goulette (two-thirds of total capacity) and at Sfax.

2.77 STIR has nearly 212,000 m^3 in storage capacity for light products, most of which is underutilized. With this surplus capacity, plus construction of two new depots at Belli (Cap Bon) and in the south, STIR should have no difficulty fulfilling its future storage requirements.

2.78 Transport. Kerosene is transported from the refinery to the distributor's depots via pipeline (Tunis) and by sea (Sfax). The pipeline linking STIR to La Goulette (71,5 km) is operated by a state enterprise (SOTRAPIL) and has been used since 1984 to transport light products, thus alleviating some of the congestion at Tunis' port. More than 53% of STIR's kerosene production was transported via pipeline in 1985. Use of the SOTRAPIL pipeline should increase once a project to extend the pipeline to Belli (Cap Bon), for which studies are well advanced, is completed. Sea transport between STIR and Sfax is handled by the Compagnie Tunisienne de Navigation (CTN): in 1985, 41,000 tons of kerosene were ferried to Sfax.

2.79 Kerosene also is transported by truck and, to a much lesser extent, by rail. The total capacity of road transport was estimated at 280 m^3 in 1985. The transport fleet primarily consists of 25 ton vehicles owned by the transport companies or distributors. Rail transport has never been used for more than a minor share of STIR's production, and its use currently is declining: rail tonnage dropped from 8500 tons in 1981 to 2280 tons in 1985.

2.80 Distribution. Seven distributors share the domestic market for kerosene: SNDP and six subsidiaries of large private companies. 23/ The distributors use their own vehicles to supply their respective depots and some of their larger clients. However, most transport to retailers is subcontracted.

22/ Often called "pétrole bleu" in Tunisia.

23/ ESSO, SHELL, MOBIL, TOTAL FINA, BP and MORY.

2.81 Retail sales of kerosene are handled by service stations, peddlers and retail merchants. At the end of 1987, there were 654 service stations across the country. Statistics concerning peddlers 24/ and retail merchants are not currently available. The latter are usually grocers or shop owners who also sell charcoal. Still, it should be noted that municipal statutes in Tunis forbid the sale of kerosene by grocers.

Gas Oil 25/

2.82 Gas oil was supplied to Tunisia in roughly equal proportions from two sources in 1987: STIR output and ETAP imports from the Mediterranean market. Most imports come through the port at Sfax (two-thirds in 1985-86, versus 23% at Bizerte and 10% at La Goulette). The share of local production will double once the refinery expansion is completed.

2.83 Gas oil, as well as domestic fuel oil, is subject to the same legal requirements for storage capacity as kerosene. Existing capacity and STIR's unused white product storage capacity are sufficient for current needs and should be sufficient in the future

2.84 Gas oil is transported from STIR to La Goulette via the SOTRAPIL pipeline (about three-fourths of STIR's 1985 production). The rest is transported by truck (total capacity in 1985 was 3000 m^3 for all light products combined), by barge (to Tunis and Sfax) and by rail. Rail transport is used mainly to supply the industrial sector (cement, sugar, chemical and paper industries).

2.85 The kerosene distributors also distribute gas oil. Retail sales are handled by service stations, but large consumers in both the tertiary and residential sectors receive delivery by truck.

Price Structure

2.86 Current price structures for the different products are presented in Table 2.6 26/ . This table shows that, except in the case of LPG, the ex-refinery price of these products is higher than comparable CIF prices for products imported from the international market; none of the products carries a net subsidy on retail price. Without precise information on the real costs of production at STIR, it is difficult to determine if ex-refinery prices truly reflect economic costs of production at STIR. In addition, the differential between ex-refinery and CIF prices is recent: data presented in Annex 9 for LPG and kerosene show that the differential was reversed (CIF higher than ex-refinery) up until 1987.

24/ There is a cooperative for peddlers, the CODIP.

25/ The analysis presented below is limited to gas-oil since domestic fuel oil in Tunisia is obtained from gas-oil with some additives and since other petroleum products (not studied up to this point) are consumed in very small quantities in the residential and tertiary sectors.

26/ This price structure has been modified by the introduction of a 6% value added tax in 1989. This modification combined with an increase of other taxes ("droit de consommation") has increased the retail prices of LPG and kerosene to D269/ton and D180/m3 respectively (February 1991), which is equivalent to around D243 per TOE of LPG and D218 per TOE of kerosene, thus maintaining about the same difference between retail prices of these two fuels.

Table 2.6: PRICES OF PETROLEUM PRODUCTS
(in D/TOE)

	Natural Gas		LPG		Kerosene		Fuel Diesel		Fuel Oil		
CIF price	73	49%	121	54%	128	66%	115	34%	114	30%	
Purchase price to STIR			106	47%	135	70%	247	74%	291	76%	
Margins distributors			56	25%	14	7%	13	4%	10	3%	
Margins retailers			17	8%	11	6%	10	3%			(*)
Domestic transport			26	12%	10	5%	11	3%			(*)
S/total without taxes			205	92%	170	87%	282	84%	301	79%	(*)
Taxes			18	8%	25	13%	53	16%	81	21%	
Retail price (A)	148	100%	223	100%	194	100%	335	100%	382	100%	(*)
CIF price + margins + transport (B)			221	99%	162	84%	150	45%	124	33%	
A-B			2		32		185		258		

(*) Based on price ex distributors' depot (without delivery cost).

Sources: 1988 data (ETAP). Price structure at July 1, 1988, maritime base.

2.87 Table 2.6 also reveals the distortions between economic costs--considered equal to CIF prices plus domestic transport and distribution costs and margins--and the prices to the consumers, as well as distortions between different products. Only LPG was sold for a price close to its economic cost in 1988, whereas the official retail price varied from the economic cost by a factor of three in the case of domestic fuel oil, and by a factor of two for gas oil.

Electricity

Generation and Distribution

2.88 National production of electric power reached 4550 GWh in 1987, after growth of nearly 8% in the preceding year. 27/ Of the total, 88% was generated by STEG and the remaining 12% by "autoproducers". There are frequent exchanges with Algeria, with a current balance of 3 GWh exported by Algeria. STEG's net production has nearly doubled since 1980: net production in 1980 was 2430 GWh, and reached 4020 GWh in 1987. Growth in the previous year (1986), when net production totaled 3750 GWh, was equivalent to 7.1%. More than 97% of STEG' production is thermally generated (80% steam and nearly 18% gas turbines); hydroelectric generation accounts for only 3% of the total, although its share is increasing. In 1987, thermally generated electricity was based on use of transcontinental gas (76% versus 21% in 1986), El Borma gas (19% versus 25% in 1986), heavy fuel (5% versus 54% in 1986) and gas oil (0.2% versus 0.1% in 1986).

27/ "Activités et comptes de gestion de l'année 1987," STEG.

2.89 In 1987, the peak load reached 710 MW, corresponding to a 6% growth from the preceding year and an increase of nearly 40% since 1981. The transmission system (225 kV, 150 kV and 90 kV) consists of 2549 km of transmission lines and 38 transforming stations. Transmission losses are about 3.7%. Energy sold to consumers totaled 3550 GWh: 20% went to the only 12 high voltage (HV) customers in the country (large industries), 47% to medium voltage (MV) and 33% to low voltage (LV). Nearly 6500 customers in the industrial and tertiary sectors make up the MV sales, which have increased by 11.4% since 1986. Growth of LV sales (mostly households 28/) between 1986 and 1987 was more moderate but still reached 7.3%. LV sales have practically doubled since 1980.

Rate of Electrification

2.90 The number of LV customers has grown at a regular pace of about 65,000 new customers each year over the past decade. As a result, total LV customers exceeded 1.2 million in 1988, more than double the number ten years before (Annex 14). LV sales in 1987 totaled more than 1200 GWh.

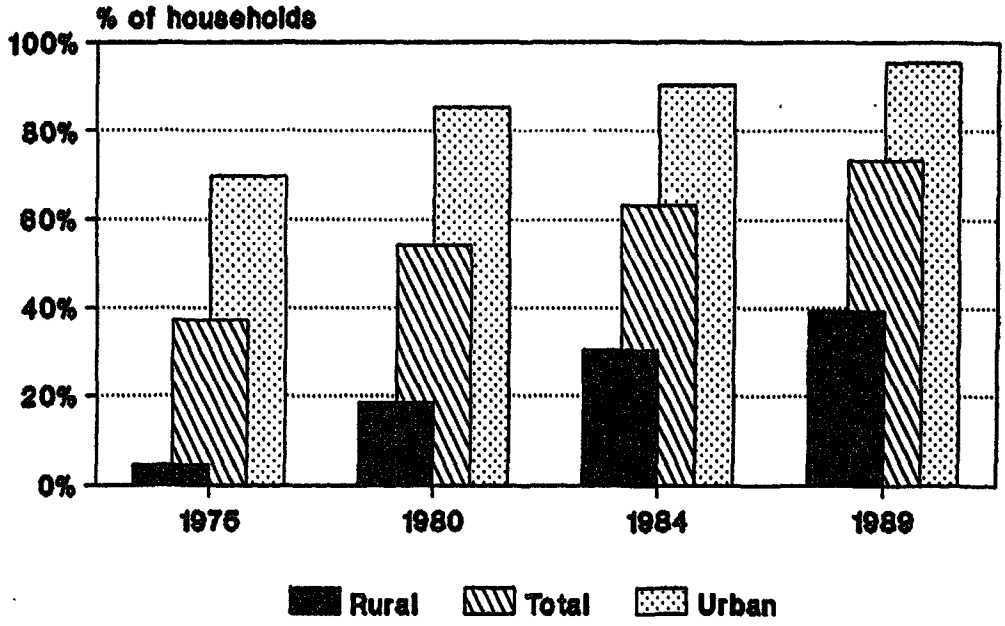
2.91 Growth rates are uneven in urban and rural areas: of the 65,300 new customers in 1987, more than 80% live in urban areas. Similarly, although the overall electrification rate for households in 1987 was 70%, the rate in urban areas was 93% versus 29% in rural areas 29/. However, in rural clusters (more than 50 inhabitants), the electrification rate reached 57%. STEG's objectives include an electrification rate of 100% for urban areas and 76% for rural clusters by the end of the period covered by the Seventh Development Plan (1987-1991).

2.92 In addition to urban/rural differences, the electrification rate for households also varies according to region, as shown in Table 2.7 and Figure 4. The Grand-Tunis metropolitan area alone contains about 28% of the total electricity subscribers and accounts for nearly 40% of LV consumption, more than double the consumption of the two Central regions combined, which only contain 18% of the customers. The electrification rate in all areas combined varies from 98% in Grand-Tunis to less than 50% in the Northwest and 40% in the Central West.

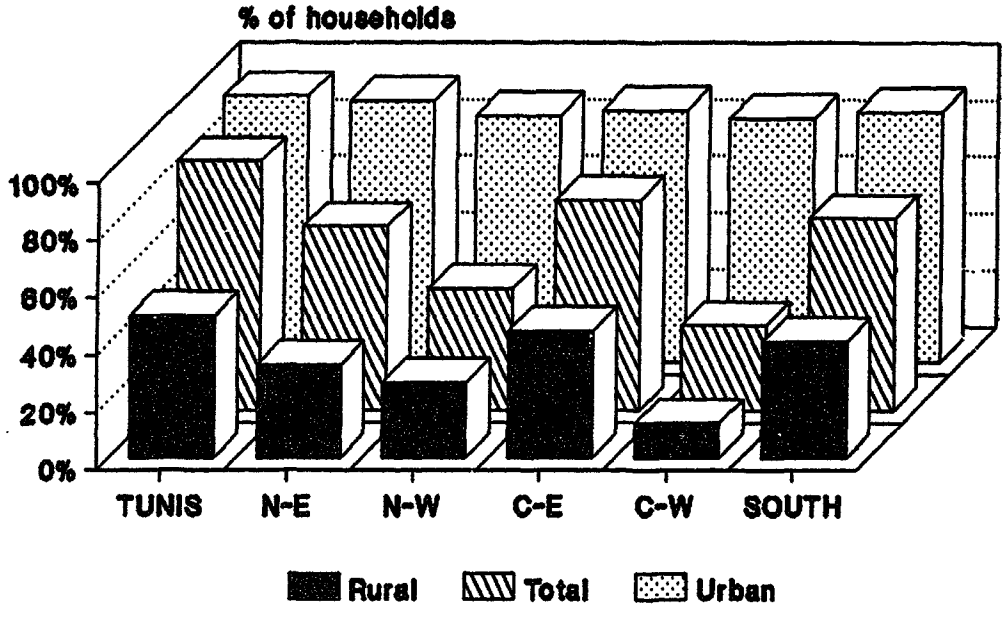
28/ Tertiary sector consumers are normally MV customers, although some of the smaller craftsmen and merchants are LV customers.

29/ Recent results of the Population and Employment National Survey show that the rate of electrification was 73.5% at national level in 1989 (95.4% for urban areas and 39.4% for rural areas), which represents an average increase of 50,000 households per year on the period 1984-1989.

Figure 4: RATE OF ELECTRIFICATION
Total Tunisia



By region in 1984



Source: INS

Table 2.7: LOW VOLTAGE ELECTRIFICATION IN 1987

	Electrif. Rate	Consumption GWh	%	Connections No.	%	Consumption per connection kWh/year
Tunis metropolitan	98%	459	39%	320,030	28%	1,434
North-East	75%					
North-West	49%					
S/total North		253	21%	274,660	24%	921
Center-East	84%					
Center-West	38%					
S/total Center		187	16%	200,580	18%	932
South-East	69%					
South-West	69%					
S/total South		278	24%	343,530	30%	809
TOTAL TUNISIA	70%	1,177	100%	1,138,800	100%	1,034

Source: STEG Activity Report, February 1988.

Present Policy

2.93 STEG is taking important steps for load management through technical means as well as through tariff incentives or data acquisition. Among these steps are:

(a) the implementation of a computerized system to manage the distribution network;

(b) the installation of centralized remote control network at transformation stations to control load shedding during peak hours;

(c) the use of night and off-peak tariffs as well as penalties for excessive power factors;

(d) the purchase of 150 recorders in 1987, with World Bank assistance, to carry out load measurements from three consumer samples (HV, MV, LV);

(e) a large, ongoing survey of households, five years after the 1984 survey, which will show the evolution since then in terms of appliances, specific consumption and consumption trends;

(f) the promotion of solar water heaters.

2.94 Promotion of the rational use of electricity is also a STEG objective. This signifies that STEG no longer engages in actions simply to promote the sale of electric power; preferential tariffs for electric water heaters now have been abandoned. It should be noted that electricity tariffs briefly reflected long-run marginal costs of supply (LRMC) in 1986 but have dropped under these costs since that date.

Renewable Energy

2.95 Tunisia has a considerable resource base for renewable energies, ranging from solar energy, abundant in practically all of the country, to low enthalpy geothermal resources, concentrated in southern Tunisia. Several organizations, including the AME, STEG, the MA and the Office du Thermalisme, have tried for several years to develop this resource base. The AME, which was establish to promote utilization of different renewable energies, financially has supported a number of demonstration projects. A total of TD 374,000 in subsidies were granted by AME between 1986 and 1988 for wind projects (67%, including 50% for wind generators and 17% for wind pumps), geothermal (21%) and solar (12%).

2.96 To date, renewable energy has had only a modest impact on the national energy balance. Renewable energy production has dropped from 26,000 and 29,000 TOE during 1985 and 1987 to about 16,500 TOE in 1988 (i.e. only about 0.5% of total final energy). More than 60% of the 1988 total was accounted for by non-woody biomass, 21% by thermal solar and 16% by geothermal, with the rest (less than 3%) divided between wind energy (mainly wind pumps) and solar photovoltaics. 30/ Most application are still marginal or experimental. Among those which are more advanced are the use of olive pits in the industrial sector 31/, small wind pumps and geothermal heating of greenhouses in the agricultural sector.

2.97 In the tertiary and residential sectors, the most well developed application without a doubt is solar water heating. It is used mostly in the residential sector (para. 2.30), with only a few installations as of yet in the tertiary sector. The profitability of individual or collective solar water heaters is examined in Chapter 3.

2.98 Other applications are all still at the demonstration stage. They include electricity generation using photovoltaic or wind systems and urban geothermal space heating. A photovoltaics generating station at Hamman Biadha (29.5 kW peak) is operated by STEG 32/ and supplies electricity to a neighboring village; its operation has demonstrated the economic limitations of centralized power generating systems (maintenance constraints, high cost per installed kW, high production cost of kWh). AME, with GTZ's assistance is currently developing with success another approach based on individual systems, whose profitability will be examined later in this report. Only two wind-powered generating stations of about 20 kW are functioning at present; STEG supervises their operation. One (El Houaria) is interconnected to STEG's MV network and the other (Jabouza) provides electricity to a village. Finally, there are only two functioning geothermal installations providing sanitary hot water to two hotels (Kebili and Mehari) from the thermal source Aïn Cheffa.

30/ "Les énergies renouvelables en Tunisie. Situation actuelle," Sadok Maherzi, DEEP/AME, February 1989.

31/ This application is by far the most important in terms of energy produced: it represents an estimated annual energy potential of 25,000 TOE during good years, more than 85% of the combined production from all renewable energy sources between 1985 and 1987. Bad climatic conditions limited the availability of olive nuts in 1988, which explains why 1988 figures are so much lower than those of the preceding years.

32/ The station was financed by a US$ 1.2 million grant from USAID.

III. PERSPECTIVES

A. Demand Projections

The Residential Sector

Socio-Economic Development

3.1 In 1989, Tunisia had about 1.4 million households. Based on the growth rates observed between the 1975 and 1984 censuses (2.6% at national level), the number of households should surpass 1.9 million by the year 2000, an increase of nearly 40%. Annex 10 presents the projections which illustrate this trend. Keeping in mind that they are merely indicative of future trends, these projections show no significant modifications to the geographic distribution of the population. However, this is not the case for the urban/rural balance. In effect, the number of urban households should grow by more than 60%, whereas rural households will only increase by around 12% and in areas with scattered population, the number of households will actually decrease by about 10%. Obviously, these population projections will have impacts on the projection of energy demand, whether it be in terms of choice of fuel, level of specific consumption or access to electricity.

3.2 However, demographics will not be the only factors influencing the evolution of energy demand in the residential sector in the short term. In addition to GNP growth rate, an influence will be felt due to changes in both the standard of living and the consumption habits which result as the population becomes increasingly urbanized. The extent and impact of these changes are difficult to predict.

3.3 Analysis of the evolution of household expenditures over the past few years is based on a historical data series provided by the INS. The data, which are presented in Annex 11, cover the decade 1975 through 1985. As economic growth was sustained during most of that period, with a slowdown only after 1984 (para. 1.5), this period was chosen to represent an average scenario for economic growth. Assuming that there is no major economic setback, the growth rate for 1975-1985 can be used as the base case for the next ten years. Thus, a population projection by category of consumer was established by linking categories (as defined in para. 2.8) with level of expenditures. The projection is presented in Annex 12.

Trends in Demand Growth

3.4 The growth trends for consumption of final energy by households was estimated according to this hypothesis. They are presented in Table 3.1. It was assumed that, at each level of consumption, both the percentage of households using wood, charcoal, LPG, or kerosene, and their specific consumption of these fuels (as shown in Table 2.3) would remain constant over time. For other fuels, factors such as STEG's electrification objectives and the projected penetration by natural gas, gas oil and domestic fuel oil for increased use in domestic space heating also were taken into account. Annex 13 provides estimates of future consumption by product.

Table 3.1: FORECAST HOUSEHOLD ENERGY CONSUMPTION
(in thousands of TOE/Year)

	1984		1987		1995		2000	
Wood a/	411	46%	422	44%	437	38%	444	34%
Charcoal	100	11%	108	11%	129	11%	143	11%
S/total Woodfuels	511	58%	530	56%	566	49%	587	45%
Average growth/year			1.2%		0.8%		0.7%	
Natural Gas	10	1%	13	1%	28	2%	42	3%
LPG	149	17%	165	17%	219	19%	259	20%
Kerosene	136	15%	146	15%	172	15%	190	15%
Diesel & Fuel Oil	22	2%	30	3%	66	6%	99	8%
S/total pet prod	317	36%	354	37%	485	42%	590	45%
Average growth/year			3.7%		4.0%		4.0%	
Electricity	56	6%	65	7%	100	9%	125	10%
Average growth/year			5.1%		5.5%		4.6%	
TOTAL	884	100%	949	100%	1,151	100%	1,302	100%
Average growth/year			2.4%		2.4%		2.5%	

a/ Wood and other biomass (straw, dung, olive nuts, etc.).

Source: Amous and Ouerghi (1986), STEG forecasts and mission estimates. (See Annexes 12 and 13).

3.5 The results in Table 3.1 show that, over the next decade, total demand for final energy in the residential sector will grow at a rate (2.5%) slightly less than the population growth rate (2.6%). Total demand thus will rise from the current 1 million TOE to more than 1.3 million TOE/year by the year 2000. This represents an overall increase of more than 30%, although there are major differences in the growth rates of individual products.

3.6 The demand for woodfuels is expected to grow at a moderate pace over the next decade, with annual growth rates probably decreasing towards a stabilized level of consumption. Given carbonization yields, the wood offtake should go from 1.9 million tons/year in 1987 to more than 2.2 million tons/year in 2000 33/. However, the share of woodfuels in the residential energy balance thus will drop from more than 55% in 1987 to about 45% in 2000. This mainly will be due to a relatively stagnant demand for fuelwood, whereas charcoal consumption is expected to grow by 2.1% p.a. between 1987 and 2000 (although still not keeping pace with population growth).

3.7 A more rapid growth rate is anticipated for hydrocarbons demand: at 4% p.a.

33/ The DGF estimates of the wood offtake are much higher, at 6.3 millions of m^3 per year which are equivalent to 4.4 millions of tons; however the mission considers that the data provided by the Amous/Ouerghi survey in 1986 are more realistic since they are based on a large sample and actual measurements of woodfuel consumptions.

(considerably more than the population growth rate), demand will reach 590,000 TOE/year by 2000, an increase of nearly 240,000 TOE over 1987 demand. At that level, hydrocarbons demand will exceed that of woodfuels, although currently the former is one-third less than the latter. According to the scenarios of fuel penetration used in the projections, growth should be most vigorous among products which presently are not used frequently: consumption of natural gas, gas oil, and domestic fuel oil should more than triple over the next 13 years. The use of LPG in households also will continue to grow at an accelerated pace, from 150,000 tons in 1987 to more than 230,000 tons in 2000, an increase of more than 50% or 3.5% p.a. Kerosene is the only petroleum product expected to increase at a pace less that the rate of population growth: 2% annual growth over the period 1987-2000.

3.8 Electricity demand is expected to nearly double between 1987 and 2000, with an average annual growth rate of more than 5%. This growth will result from STEG's ongoing electrification programs, especially in rural areas. However, demand growth will slow as the rate of electrification in urban areas approaches 100%. In terms of primary energy, residential demand for electricity will reach 410,000 TOE/year by 2000.

3.9 Even though final demand for hydrocarbons and electricity in the residential sector will increase at a sustained pace for the next few years, the anticipated growth rates are significantly lower than those of the preceding decade. The data on past product sales, presented in Annex 14, confirm that annual growth rates between 1977 and 1987 averaged 12% for LPG, more than 4% for kerosene and nearly 9% for electricity. However, much slower growth already was apparent at the beginning of the 1980s. For example, the growth rate of LPG and kerosene sales during 1984-87 was only one-half the average growth rate during 1977-1984.

The Tertiary Sector

3.10 Future activity in the tertiary sector is expected to develop at a sustained pace, as in the past. The sector's contribution to GDP has risen progressively from 48% in 1985 to 53% in 1988 and total value added in the sector has increased at an annual rate of 4.7% since 1984. Some subsectors have expanded even more rapidly, as is the case for hotels and restaurants, whose value added has increased by 14% p.a. over the past four years. This subsector is expected to expand even further with the implementation of tourism projects along the north coast of the country. On the other hand, subsectors like the Turkish baths will develop less rapidly as more bathing facilities are installed in residences.

3.11 Anticipated growth in the tertiary sector will necessarily bring about an increase in its demand for final energy. Even so, this will not be the only factor affecting energy demand. The plans for developing use of natural gas and for energy conservation in the sector probably will have a significant impact on the structure of demand in the medium- to long-term.

3.12 However, it is difficult at present to generate reliable demand projections for the tertiary sector, for the following reasons:

(a) There is no reliable data series for the sector; with the exception of the 1987 energy

balance presented in this report, prior energy balances for the tertiary sector have been established by default on the basis of information contained in national energy balances and energy balances for other sectors.

(b) None of the studies or surveys of the sector undertaken to date has taken into account woodfuel consumption (except the surveys of restaurants and Turkish baths carried out during this study).

(c) There is also no data series for the subsectors of the tertiary sector covering number of enterprises, energy intensity, categories of consumers, etc. (see para. 2.34 and 2.35).

(d) STEG's objectives for natural gas penetration have yet to be clearly defined, mainly because the feasibility of gas penetration in several subsectors has not yet been ascertained.

(e) Although the potential for energy savings identified in several audits is considerable, few recommendations have been implemented and it is too early to estimate the future impact of ongoing and anticipated audits.

3.13 The information available only allows for partial projections for particular subsectors and/or fuels. This is the case with natural gas penetration in the hotel subsector. Projections are based on the assumption that natural gas will be used in all new hotel capacity in the areas to which gas is distributed; this new capacity amounts to 5500 beds per year in the short term. Assuming an average occupancy rate of 50% and average gas consumption of 2.5 m^3 per hotel night (see Annex 6), projected annual increases in natural gas consumption within the subsector will amount to 2250 TOE, for a total increase of 29,250 TOE over 1987 levels by 2000 (Table 2.4). Given that consumption in existing hotels already connected to the gas distribution network most likely will grow despite potential energy conservation measures which could be implemented, natural gas consumption in hotels could reach 50,000 TOE/year by the year 2000.

3.14 Available data also are sufficient to make estimates concerning electricity. According to data from STEG and INS, electricity demand in the tertiary sector grows at more than 6% per year, or 30% more rapidly than the growth of value added in the sector. General estimates of future trends in electricity consumption can be made based on this information: the total demand for the tertiary sector in terms of final energy could surpass 130,000 TOE/year (1510 GWh) in the year 2000, more than double the 1987 consumption.

3.15 On the other hand, with the exception of recent sales data for LPG and kerosene (Annex 14), there is little information to project petroleum product consumption in the sector. In the case of LPG and kerosene, both fuels are consumed almost totally by the residential and tertiary sectors. Thus, it is possible to compute an estimate of future tertiary demand by taking projections for the residential sector in Table 3.1 and subtracting them from the total projected consumption of the two fuels. As for other products, this type of calculation would become complicated, since the amounts which will be substituted by natural gas are difficult to estimate. Still, an estimated annual growth rate of 4%, slightly less than the growth of value added in the

sector, would bring the consumption of petroleum products by the tertiary sector to more than 180,000 TOE per year by the year 2000, an increase of 70,000 TOE over current levels.

3.16 The projections and scenarios outlined above are consolidated in Table 3.2. According to this table, the demand for final energy in the tertiary sector probably will double in the next 15 years. It could surpass 370,000 TOE/year by the year 2000, an increase of more than 180,000 TOE/year over 1987 levels, which corresponds to an average annual growth rate of 5.2%. This rate is slightly more than that of value added in the sector, which implies that the energy intensity of the sector will continue to grow. Tertiary demand, equivalent to 20% of the energy demand in the residential sector in 1987, thus could correspond to 30% of residential demand in the year 2000.

Table 3.2: FORECAST GROWTH OF FINAL ENERGY CONSUMPTION IN THE TERTIARY SECTOR (in thousands of TOE/year)

	Consumption 1987	Growth Assumption	Consumption 2000	Difference 1987-2000
Natural gas				
Hotels	15.5	additional capacity of 5000 beds/year connected to gas grid	50	35
Others	3.4	6% per year	7	4
S/total Gas	18.9		57	38
Petroleum products	110	4% per year	183	73
Electricity	62	6% per year	132	70
SECTORAL BALANCE (excluding biomass)	190.9		372	181

Source: Mission estimates and Table 2.5.

B. Issues and Constraints of Energy Supply in the Sectors

3.17 Based on the situation described in Chapter 2, existing and future issues and constraints of energy supply in the residential and tertiary sectors are presented in what follows. The analysis is divided in three parts, dealing respectively with energy sources, end-use equipment and institutional aspects.

Woodfuels

Regional Differences of Environmental Impact

3.18 As stated above and estimated by the mission (paragraph 3.6), woodfuel demand in 1987 is equivalent to an offtake of 1.9 million tons of wood, or nearly 2.4 million m^3. This offtake is expected to increase in the short term to reach 2.2 million tons in the year 2000. Without accurate data concerning wood availability (see para. 2.48 and 2.50), it is difficult at present to estimate the actual impact this offtake will have on the Tunisian environment. Also it is difficult to separate quantitatively the role of wood-energy production from the other causes of forest resource degradation, such as overgrazing, land clearing for agriculture purposes, fires, etc. These activities usually play a dominant role in deforestation.

3.19 The impact of wood-energy production will vary according to region. In the southern part of the country, insufficient forest resources is not a new phenomenon with the exception of the highlands where there are still several major forests. 34/ Offtake for energy purposes only aggravates the situation, especially in semi-arid or arid regions. In the Central West, where remaining natural forest formations are concentrated mainly on hills and mountains, fuelwood is collected by local residents both for their own use and to be commercialized for supply to cities in the region, thus contributing to deforestation which already is quite advanced in some areas. This deforestation along ridges presents considerable dangers to the environment, including increased erosion and altered hydrological patterns.

3.20 Similar risks exist in localized pockets of the Northwest. However for the most part, this region - which comprises most of the country's forest reserves - has a supply potential which is significantly greater than the local demand. Local woodfuel consumption thus does not represent a major threat to the environment. The situation is even more favorable in the Central East, in particular in the Sahel, where pruning of olive and almond trees generates several thousand tons of wood each year (see para. 2.51), far exceeding the quantities consumed locally. In that region, use of woodfuels is likely to be limited to the by-products of trimmings, thus exerting little additional pressure on the environment.

Poor Monitoring and Control

3.21 In 1988, the DGF marketed approximately 122,000 tons of wood-energy, of which only 33,000 tons was in the form of fuelwood (the rest, in theory, was used to produce charcoal). In addition, about 13,000 tons were marketed as construction or industrial wood. That same year, DGF estimated that an additional 500,000 tons was exploited under the system of "user's domain". These figures are to be compared with consumption estimates for the same period: according to Table 3.1, consumption in the residential sector alone amounted to 1.14 million tons, or double

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34/ There are, for example, forests of holm oaks at altitudes over 1000 m. and Alep pines at altitudes of 500 to 800 m. on the Haut Tell massif.

DGF's supply estimates. 35/ The differential is even larger for charcoal: charcoal permits were granted for production of 37,000 tons (28,000 tons using olive wood), whereas estimated consumption was nearly triple (110,000 tons).

3.22 It thus appears that the mechanisms for monitoring woodfuel production are not efficient. Even with the addition of wood generated from olive tree trimmings (825,000 tons/year - para. 2.51) to DGF's above data, total supply reaches only 1.45 million tons, which is 25% less than current demand of 1.9 million tons. Thus nearly 500,000 tons of wood are not accounted for each year by official controls. It is possible that much of the charcoal consumed in rural areas is produced without a permit: wood used for this purpose is likely to come mainly from fruit trees, wind-break hedges or isolated trees in fields. Much of the charcoal produced using olive tree trimmings also is likely to escape official controls. Finally, the user's domain itself could be subject to fraudulent practices and tenurial aspects should be reviewed (possibility of leasing state forest to private wood producers to achieve efficient and sustainable exploitation).

3.23 Thus, although local supply/demand balances for woodfuels may show a surplus in the Northwest and the Central-East, it will not be long before difficulties arise in these regions, also. In fact, the regions constitute the main supply sources for fuelwood and, especially, charcoal marketed in large urban areas, including the capital. Since it is not possible to pinpoint with accuracy the exploitation zones, it is difficult to ascertain if, in these zones, the offtake of wood surpasses the regenerative capacity of forest reserves.

Limited Prospects for Improvement in Efficiency of Cookstoves and Carbonization Techniques

3.24 The brief analysis presented above indicates the possible risks to the environment linked to woodfuel consumption. It is necessary to evaluate the extent to which offtake of wood can be reduced, one of the ways being improved efficiency in woodfuel production and use. The following conclusions could be drawn during the Study concerning improving the efficiency of (a) wood and charcoal cookstoves, and (b) traditional carbonization techniques.

3.25 Improved Stoves. Two models of improved stoves were developed during the Study, one to replace the three-stone stove and the other to replace the clay canoun. Both are inexpensive, simple (rustic) metal stoves which can easily be manufactured by craftsmen. Efficiency tests (see Annex 18) run on the stoves show savings of wood and charcoal reaching 30% to 50% (in the case of proper use of stoves). Unfortunately, trials to test the acceptability of these models for consumers in Kef and Cap Bon, regions where the three-stone stove and the canoun respectively are widely used, suggest that there is little chance of successfully distributing them.

3.26 In the case of the improved wood stoves, there appear to be two main factors limiting acceptability. The first arises from fuelwood's poor image. For most fuelwood consumers, use of wood is not a voluntary choice; rather it is a choice imposed by their modest incomes, which preclude purchase of other fuels when wood can be obtained free (users' domain). Second, the consumer also has little incentive to try a new wood stove which, even if improved in terms of

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35/ The level of fuelwood consumption in the tertiary sector cannot be estimated, with the exception of consumption by Turkish baths, which reached about 46,300 tons in 1987 (Annex 8).

efficiency, remains rudimentary and far from an image of modernity. The third factor is the price of the improved stove: although it is very inexpensive, the alternative--the three-stone stove--is free. Here again, the modest income of the fuelwood consumer presents a major constraint: the household has more pressing expenses, so why, the consumer reasons, buy a stove which helps save a fuel that he/she doesn't pay for in the first place?

3.27 Different factors limit the acceptability of improved charcoal stoves. The clay canoun is a traditional appliance used primarily for making tea, which itself is a traditional and leisure activity. In addition, charcoal expenditure for tea-making weighs little in the total budget of households. As a consequence, fuel saving is not a priority for the canoun user. Thus, it is unlikely that an improved charcoal stove can be successfully distributed in areas where the Sfax (metal) canoun - more efficient than the clay canoun - already has not succeeded in penetrating the market.

3.28 Improved Carbonization Techniques. The carbonization yields obtained from the traditional earth kilns by Tunisia's professional charcoal producers are very good for that type of technology (see para. 2.58). There are three reasons for this: (a) the technical know-how of the producers, accumulated over many years (charcoal production is not a new activity in Tunisia); (b) the economics of high productivity, which induce the producer to produce as much charcoal as possible from a given quantity of purchased wood; and (c) the types of wood most often used (oak and olive), which carbonize well because of their high density and usually low humidity level. The efficiency of charcoal production by non-professional charcoalers is probably not as high as professionals' efficiency. However, the former are usually scattered, produce small quantities, not as a permanent occupation (part-time seasonal activity) and operate without permit; therefore, it would not be realistic nor justified to target an improved charcoaling efficiency program on these producers.

3.29 Under these circumstances, even though technical improvements are always possible, it is unlikely that they would appreciably improve production yields. Any improvements would be gained through a more complex technology and at higher cost, which would severely limit financial viability and prospects of diffusion. Only adoption of semi-industrial or full industrial carbonization techniques would significantly improve yields. However, implementation of this option would not be without its own complications - it would introduce new problems for collecting and transporting wood - and it is not clear that it would be economically viable. There is an additional environmental risk as compared to the current system, which uses relatively small, scattered worksites. Implementation of a semi-industrial or industrial carbonization unit would generate a large, concentrated market for wood destined for carbonization, which would provide incentives for the neighboring population and merchants to over-exploit forest reserves nearest the unit.

Hydrocarbons

Increasing Imports

3.30 It is projected that Tunisia will become a net energy importer of some 2.5 to 4 million TOE per year by 2001 (para. 1.12). The residential and tertiary sectors, whose consumption

of hydrocarbons is expected to increase at a sustained pace (4% p.a.), most certainly will affect the need for increased imports. Still, these will not be the only sectors affecting the most the energy balance: industry, generation of HV electricity and transport will weigh more heavily in the balance of payments. The projections presented above (Table 3.1 and 3.2) show that hydrocarbon consumption in the two sectors will go from 483,000 TOE/year in 1987 to about 830,000 TOE/year by the year 2000, assuming current growth trends. This represents an increase of nearly 350,000 TOE/year, equivalent to 10% of the net imports projected for that period.

3.31 Nevertheless, increasing the imports will be necessary and important for certain products. Indeed, the anticipated expansion of STIR's refinery capacity, from 1.5 million tons per year to 3 million, will be sufficient to cover the growth in kerosene demand, but not LPG and gas oil. In the case of LPG, STIR's production capacity will be augmented to 46,000 tons per year, but this increase will be offset by the gradual reduction of production from the Gabès gas plant as reserves at El Borma are depleted. The DGE's projections for the structure of LPG supply are presented in Table 3.3 and show that LPG imports will nearly double in the next eight years. As for gas oil, imports already represented nearly half the internal demand (Annex 4). Demand for gas oil is likely to grow by 4% per year, meaning that demand would double in just over 15 years. Thus, even though the refinery expansion will double local gas oil production, gas oil imports also will double over the next two decades.

3.32 The need for more LPG imports will increase existing congestion of Tunisia's ports, especially if LPG continues to be shipped in relatively small cargoes. As a result, the fees charged for delayed offloading will only increase. 36/ Thus, use of larger tankers for LPG imports should be considered in order to relieve somewhat the port congestion and reduce transport costs. DGE already has recommended that a 4000-ton tanker be purchased (currently LPG import cargoes are between 700 and 1700 tons).

3.33 Increased imports in addition to continuing production will also mean increased environmental risks. Oil spills are at stake in oil production and storage facilities, especially offshore. The 1989 World Bank Country Environmental Study has recommended a number of preventive measures to limit such risks.

Inadequate LPG Storage and Bottling Facilities

3.34 The projected increase in LPG demand will tend to aggravate current shortages in existing stock capacity (para. 2.70). DGE's estimates of the evolution of these shortages are presented in Table 3.4. The estimates show that an additional 14,200 tons of capacity will be needed by 1996 - nearly equivalent to existing capacity - assuming there are no changes in demand trends or existing capacity. DGE also estimates that by 1996, distributor and STIR stocks will be reduced to about 17 and 7 days respectively: this is far below the legal requirement of one month's security stocks.

3.35 DGE has estimated that at least TD 12 million in cumulative investments will be required by 1996 to cover projected capacity shortages for LPG stocks. Investments would include

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36/ These charges were TD 1/ton in 1985, but had reached TD 3.3/ton in 1983.

a 7700-ton addition to the capacity of depots in the north and creation of a new 5500-ton depot in the Sahel region. Moderate shortages will continue in the south, however, and new investments will not be sufficient to meet legal requirements for security and bottle stocks.

3.36 Table 3.4 also shows that an estimated 1.9 million 13 kg bottles will have to be refilled during peak periods to satisfy demand in 1996. This total represents a shortfall of 300,000-13 kg bottles relative to the combined filling capacity of the five existing centers. The shortfall could be alleviated either by operating existing centers for two more hours each day, or by constructing a new filling station with a capacity of 1300-13 kg bottles per hour. The latter solution would require a TD 5 million investment, according to DGE's estimates.

Table 3.3: FORECAST LPG SUPPLY

	1988		1992		1996	
	(tons)	(%)	(tons)	(%)	(tons)	(%)
Production STIR	32,700	16%	46,000	19%	46,000	17%
Production Gabs Factory	53,300	26%	37,000	16%	22,000	8%
Importations	116,000	57%	154,000	65%	209,000	75%
Total a/	202,000	100%	237,000	100%	277,000	100%

a/ Global growth rate: 4%/year.
Source: Energy General Directorate, SEME.

Table 3.4: FORECAST REQUIRED LPG STORING AND FILLING CAPACITY

	Unit	1989	1992	1996
Forecast LPG assumption a/ (all sectors)	tons/year	210,000	237,000	277,000
STORAGE:				
Existing storage capacity:	tons	21,000	21,000	21,000
including distributors	tons	15,000	15,000	15,000
STIR	tons	6,000	6,000	6,000
Storage needs b/:	tons	26,400	30,700	35,200
including distributors	tons	23,500	26,300	30,800
STIR	tons	2,900	4,400	4,400
Storage deficit:	tons	(5,400)	(9,700)	(14,200)
including North	tons	(2,300)	(5,400)	(7,700)
Center (Sfax)	tons	(4,200)	(4,800)	(5,500)
South (Gabs)	tons	1,270	500	(1,000)
FILLING:				
Existing filling capacity	13kg/bot./month	1,600,000	1,600,000	1,600,000
Filling needs c/	13kg bot./month	1,461,000	1,640,000	1,918,000
Filling deficit	13kg bot./month	139,000	(40,000)	(318,000)
NEW BOTTLES NEEDS d/	13kg bot./year	206,000	224,000	261,000

a/ Consumption growth rate estimated at 4% per year.
b/ Security stock = 1 month of sales during previous year. Minimum reserve of bottles at estimated at 10 days of sales for the distributors and 5 days for the STIR.
c/ Sales of 13kg refills = 90% of total consumption. Filling needs in peak period = 10% of annual consumption.
d/ Bottle rate of rotation = 5.5 times per year. Replacement rate = 3.5% of all bottles every year.

Source: Estimates of Energy General Directorate, SEME.

Distorted Price Structures

3.37 The price structures of the main hydrocarbons used in the residential and tertiary sectors (see Table 2.6) illustrate the existing distortions between CIF import prices, ex-refinery prices, and retail prices. These distortions give certain signals to consumers:

(a) LPG is favored over kerosene in the residential sector: if the differential 37/ between the economic costs of the two products were reflected at the retail level, then LPG would be priced at TD 59/TOE more than kerosene i.e. about 30% more

37/ Since the cost of LPG on the mediterranean market is highly volatile (much more than the cost of kerosene), the above difference can vary widely on a monthly basis. For instance, in January and February 1991, the cost of LPG (FOB mediterranean) was about US$200/ton higher than the cost of kerosene, while in June 1991 LPG costed US$80/ton less than kerosene. However an analysis on a longer period shows that CIF costs of both fuels tend to be at the same level (e.g. about US$200/TOE in February 1992), which would maintain in average the above mentioned difference of about D60-70/TOE in favour of kerosene in terms of economic cost at retail level.

(when the current differential is TD 29/TOE i.e. 15% more) and thus LPG would be less attractive; the distortion clearly favors the wealthier households (main users of LPG) while penalizing the low-income ones.

(b) Pricing favors the use of kerosene by certain tertiary sector establishments instead of, or in combination with, gas oil; this is especially the case for hot water heating in some Turkish baths. Normally, kerosene use should be reserved for households.

3.38 These distortions occur largely because the Government fixes both STIR's purchase price for crude oil and its ex-refinery prices for different products. Without analytic accounting data, it is difficult to determine the real economic costs of refinery operations, product by product, which should orient the fixation of ex-refinery prices by the Government. Still, STIR's refining costs appear excessive when compared with those of other Mediterranean refineries; 38/ Excessive local costs mainly are the result of overstaffing and some run-down or obsolete equipment, and they partly explain why ex-refinery prices, with the exception of LPG, are fixed at levels significantly higher than the CIF import cost.

Constraints to Natural Gas Penetration

3.39 Natural gas penetration has been successful in the hotel sector: at present, an estimated 80% or more of all hotels are connected to the network in areas where gas is distributed. 39/ This level of penetration most certainly was achieved because the policy to promote gas was well conceived: in the first phase, STEG paid - with financial assistance from the World Bank - for all conversion costs (connections, regulator and internal piping) of hotels constructed before 1983, some 200 in number. However, these benefits gradually have been eliminated. During the second phase and for hotels built between 1983 and 1986, STEG only paid for connections and regulators. Hotels constructed since 1987 must assume all conversion investments themselves. Nevertheless, given natural gas' low cost to the users, new hotels usually take the gas option.

3.40 By contrast, natural gas penetration into the residential sector has encountered real difficulties. The numbers confirm this: urban areas along the existing pipeline include some 320,000 households, whereas the number of residential gas customers totaled about 35,000, less than 12% of the potential market. In addition, after a steady increase from 1850 new customers in 1984 to 3200 in 1987, an average of 20% per year, new connections slowed in 1988 -only 2000 new customers were connected to a distribution network initially designed to accommodate 3500.

3.41 Yet, with current energy prices, natural gas used for cooking, water heating and space heating yields a clear financial advantage relative to LPG and other petroleum products (Table 2.6). Thus, it is apparent that the costs of connection and internal piping are the main constraints to more rapid penetration of this fuel into the residential sector. In fact, in contrast

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38/ The poor relative performance of Tunisia's refinery was underscored between 1979 and 1983, when ETAP processed Tunisian crude in other Mediterranean refineries and thus was able to compare the costs and output with that of STIR.

39/ In Sousse, Hammamet, Nabeul and Monastir, the level of penetration is 95%; in Tunis, it is 80%.

with STEG's initial policy for hotel conversion, these relatively high costs - with few exceptions - must be borne entirely by the consumer.

3.42 In economic terms, the average incremental cost of gas distribution to households should be lower than the difference between the cost of distributed LPG and the border price of natural gas, i.e. about DT150/TOE in 1988, equivalent to about DT4 per 1000 cubic feet of gas. This is likely to be achieved only in new, high density dwellings (e.g. buildings) with upper range energy consumption for both cooking and water heating. This has been confirmed by economic studies of gas distribution performed by STEG since the completion of this Study.

3.43 The costs of connecting a household to the existing gas mains include work done by both STEG and private contractors (generally plumbers to install internal piping). STEG's connection tariffs are standard: they vary from TD 50 for an apartment in a new development where gas distribution has been integrated into the construction, to TD 370 for houses located within 30 meters of the mains. For longer distances, tariffs are based on specific cost estimates established by STEG. Table 3.5 gives three examples where the price paid by the customer varies from TD 155 to TD 470. The costs of interior piping 40/ depend on the configuration of the house or apartment and on the gas end-uses. For a small lodgings where gas is used only for cooking, the average cost is about TD 350 to TD 400; costs can reach TD 700 to TD 800 for a house with a gas furnace. Thus, in the most favorable case - small apartment with only gas cooking - the minimum price paid by a new customer is TD 400 to TD 450 for connection and interior piping, not including possible conversion costs for replacing household appliances. The price of connection and interior piping can exceed TD 1000 for a house with central heating. The obstacle of high connection costs could be lessened by integrating a monthly payment to the STEG bill over a period of one or two years; however, this payment should not be integrated into the gas tariff itself, since this would produce an economic distorsion.

Table 3.5: EXAMPLES OF NATURAL GAS CONNECTION COSTS IN THE RESIDENTIAL SECTOR

			Extension		Distribution		Total	Total	Price	
Place (date)	Type of housing	Number connect	length (mt)	cost (DT)	length (m)	cost (DT)	Divers a/ (DT)	length (mt/user)	cost (DT/user)	paid (DT/user)
National guard El Aouina (June 87)	appart.	162	660	20,565	445	3,767	13,768 b/	7	235	155
Gammarth (sept. 88)	houses	300	960	27,488	9,822	74,875	38,678	36	470	-
Bizerte (July 88)	houses	175	-	-	4,850	37,718	2,864	28	232	370

a/ Including costs of pavement and sidewalks repairing.
b/ Including nine wall head pipes.

Source: STEG invoices, Department of Gas Studies.

40/ This comprises all installation work done within the confines of the property boundaries in the case of a house, or, starting from the edge of the landing in the case of an apartment.

3.44 These prices can be compared with the household expenditures (Annex 11). For a middle class family of five or six, the outlay necessary to have gas cooking represents, in the majority of cases, more than their average annual housing expenditure and nearly five times more than the total annual energy expenditure. Indeed, STEG offers an installment plan for repayment over 20 bi-monthly periods, but this only covers STEG's part of the connection charges. Similar payment facilities are not offered by the private contractors, although their charges represent most of the connection cost.

3.45 Thus there is no bona fide incentive policy for promoting natural gas usage in the residential sector. In addition to insufficient financial incentives, there is no campaign to inform customers of the benefits of using gas, and the policy for distributing gas in cities and towns does not seem based on constant criteria anymore. It seems, therefore, that there is still considerable work to be done to achieve SEME's objectives, though modest: triple the number of gas customers by the year 2000 and increase the target growth rate from 5000 new customers per year during the Seventh Plan (1987-1991) to 10,000/year during the Ninth Plan (1997-2001).

Electricity

3.46 Continued economic development in Tunisia together with population growth and development of electricity distribution will combine to sustain growth in electricity consumption. Since 1980, the total demand for electricity has grown annually by 7%, a rate considerably higher than growth in total demand for all forms of energy combined (3.2% p.a.). Similarly, the relative energy intensity of electricity in the economy 41/ is currently increasing by 3% per year, whereas the overall energy intensity (all forms of energy) shows a slight decrease. According to projections provided by SEME and STEG, electricity demand should grow at an average annual rate of 6.5% during the next decade; total demand should reach 8600 GWh in 2001, almost double the demand in 1988 (3800 GWh). These projections are based on the hypothesis that electricity will reach 97% of all households by that date (excluding dispersed households in rural areas).

3.47 Demand growth of this magnitude should be accompanied and monitored in order to minimize energy losses and to avoid mistakes in both technical energy choices and in building and equipment design, with the goal of limiting already high investment requirements for generation (para. 1.26). For their greater convenience at the least cost, households should be able to have a choice of well-priced, durable appliances with guaranteed levels of energy efficiency. The tertiary sector establishments, both public and private, should offer the best service and best convenience to the user, while simultaneously minimizing their electricity expenditures.

Need for Load Management

3.48 STEG already has achieved considerable progress in managing load growth (especially peak load) and reducing distribution losses (para. 2.94). At present, STEG keeps close tabs on demand and is actively developing mechanisms for (a) tracking peak demand, (b) projecting

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41/ Energy intensity is defined as the quantity of energy consumed per unit of GDP.

demand, and (c) managing demand through incentives (tariffs, conservation policies) or direct action (load shedding by remote control during peak hours).

In order to succeed in these endeavors, STEG has identified two priorities:

(a) A data bank covering electric household appliances should be created. This has been started partially during this Study and should be complemented with the results of the STEG's 1989 survey; however mechanisms for annually updating the data bank have yet to be implemented.

(b) Sectoral load curves need to be established: In-depth knowledge of the load curve for each sector is indispensable for accurate interpretation of structural changes in the aggregate curve, for determining load curves and demand projections, and for optimizing the utility's technical load management ability.

3.49 STEG is measuring loads in new samples and analyzing data to establish load curves by customer class. The objective is to be able to simulate future load curves using simple models which combine representative curves from homogenous customer classes. STEG's technical resources - software, microcomputers, plotters - appear sufficient for the task.

Constraints to Interconnected Rural Electrification

3.50 Although STEG's objectives for electrification are quite ambitious, it is estimated that between 250,000 and 300,000 households still will not be connected to the electric power grid by the end of the Seventh Development Plan (1987-1991). Most of these households are scattered in distant rural locations (Annex 10), where the costs of extending the electricity grid are very high. In addition, their electricity consumption will not generate sufficient revenues to cover these costs. Thus, these households could only be connected to the grid if large subsidies were provided.

3.51 By contrast, decentralized systems such as photovoltaics may offer a least cost solution for providing electricity to small consumers dispersed throughout rural areas. The AME, with assistance from the GTZ 42/, has initiated a demonstration project in the Kef Governorate. Both one- and two-panel systems have been installed, capable of providing enough power for basic needs such as lighting, radio and television. These systems costs between US$500 and US$1100. A preliminary analysis of the economic viability of this option is given below.

New and Renewable Energy

A Market for Decentralized Photovoltaic Systems

3.52 Photovoltaic systems could be used to supply low-level electricity to scattered consumers for which prevailing low levels of demand made clasic rural electrification non

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42/ Special Energy Program (SEP).

economically feasible. The Study's economic analysis takes into account the additional investment needed for this type of equipment; it is based on the cost of the service provided rather than the cost per kWh, because electricity consumption of households equipped with photovoltaic systems is much lower than the consumption of households connected to the grid. The analysis shows that:

(a) For modest consumption corresponding to four hours of daily usage for lighting (equivalent to two incandescent 75 W lamps) and a television set (i.e. about 7.5 kWh per month), photovoltaics prove less expensive than extending the grid if service is provided to fewer than 20 to 25 customers per km of MV line, with a worst month solar radiation of 4 to 5 kWh/m²/day;

(b) However, the costs of a photovoltaic system are proportional to the daily load, whereas the cost of a connection to the grid is relatively independent of the load. Thus, the economic viability of the solar option decreases rapidly for higher levels of specific consumption: when the monthly load is increased by another 16.5 kWh, 43/ photovoltaics will no longer be competitive with extending the grid if the number of customers served rises above 5 to 6 per km of MV line.

3.53 Thus, the economic viability of photovoltaic systems is highly sensitive to the daily load of the user. The potential market for these systems will depend on the level of electric service desired by the consumers. In addition, systems can be installed only if the costs are assumed by the consumers themselves and/or if the Government subsidizes them or sets up credit facilities. As a result, although there are Tunisian households for whom photovoltaics certainly constitute the least cost option for electricity supply, the actual size of this market currently is not known with any accuracy. A proper evaluation will be possible once ongoing studies within the AME/GTZ project are completed.

Limited Market for Solar Water Heaters

3.54 Solar water heaters have been in use in Tunisia since 1985, and sufficient data has been generated to establish their development potential. At present, the number of installations (about 7,000 in 1989) is equal to 10% of households using electric water heaters (assuming 1984 equipment levels -- Table 2.1). This is a substantial penetration level after only three to four years; it is much higher than penetration levels in countries like the United States, where the solar water heater industry has existed for more than 15 years. Current incentive policies, such as the exemption from custom duties for primary materials used to manufacture solar water heaters, thus appear justified and well adapted: they should be continued as is. The same holds for installed industrial capacity, which is viable and sufficient to cover present demand. It is unlikely that the market will develop more rapidly as long as energy prices stay at current levels. However, should the situation change, the technology and skills necessary to respond rapidly to market growth will already be in place.

43/ Such a load increase would be equivalent to five additional high efficiency lamps (lit for four hours each day).

3.55 The financial and economic viability for individual and collective solar water heaters was assessed during the study. 44/ Both economic and financial analyses show similar rates of return, suggesting that the Government's policies regarding solar water heating production and use are sound.

3.56 Simulated comparisons of individual water heaters show that new or, even retrofit, solar water heaters are not competitive with natural gas- or LPG-fueled water heaters. Comparisons with electric water heaters are more favorable; however, the comparison does not justify retrofitting an existing electric heater, but does show that the solar heater competes well with its electric counterpart at the time of initial purchase. Thus, the market for individual solar water heaters appears to be limited by:

(a) in general terms, the fact that few households have water heaters (less than 15% in 1984);

(b) in specific terms, the fact that few households use electric water heaters (about 5% of total households in 1984);

(c) the solar water heater's only marginally better rate of return relative to electric water heaters;

(d) the existence of alternatives which are economically and financially more favorable, such as natural gas or LPG heaters.

3.57 On the other hand, the initial investments required for solar water heaters do not appear to be a constraint. STEG offers very attractive financial terms (10% down payment, the balance paid a highly favorable 6.15% interest rate), with payments incorporated into the regular electricity bills. These terms have even more appeal to households now that STEG's special tariff for electric water heaters has been eliminated.

3.58 Comparisons between collective solar water heaters and alternatives give similar results. The solar option is not cost-effective for hotels when compared with natural gas water heaters. On the other hand, it is competitive for establishments which do not have access to gas and which use gas oil. Thus, as with individual solar water heaters, the market appears limited.

Household Appliances

Insufficient Control of Quality

3.59 Locally produced household appliances are relatively efficient, as most Tunisian manufacturers are licensed by large, competitive (primarily) European manufacturers. In general,

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44/ Source: Mission report and "Analyse financière des installations solaires pour les secteurs résidentiel et tertiaire en Tunisie," Sadok Maherzi, July 1989.

local manufacturers have small testing stations in their factories and have implemented basic quality control procedures. In addition, uniform standards have been developed for specific appliances.

3.60 However, available testing equipment does not allow accurate measurements, and as long as the certification process to ensure conformity with standards does not operate, quality guarantees remain limited. Also, AME cannot publish the data on appliance energy efficiency unless they are certified according to INNORPI procedures and thus, these data cannot be used by either consumers or manufacturers 45/. Another problem arises because manufacturers do not have the equipment to control the quality of imported parts. Thus, appliances may be prone to breakdowns or premature obsolescence, which cannot be discovered by advance testing.

Low Productivity in Local Manufacturing

3.61 Household appliances were first manufactured in Tunisia by state enterprises created in 1975; these enterprises have progressively been required to compete with and largely have been supplanted by private companies. At present, three state enterprises, which often depend on government subsidies for their survival, and a dozen private companies share the market for different appliances. Together they form the Trade Association for Appliance Manufacturers (within the UTICA), which represents their interests at the national and regional levels.

3.62 The low productivity of local enterprises is translated into either high retail prices or poor financial performance when the market or the company's contractual arrangements limit the retail price. Although labor costs are low, they cannot offset low productivity caused by underutilized capital, which in turn is caused by the limited size of the Tunisian market. In addition, the cost share of locally produced parts used in manufacture (level of integration) remains low to average. It appears difficult however to increase the current level of integration for most appliances. Local enterprises will continue to import parts - manufactured in Europe or elsewhere for much larger markets - at unbeatably low prices (due to modern manufacture technologies) which cannot be offset by Tunisia's low labor costs.

3.63 Providing incentives for increased competition among firms is not an easy solution either, given that the market is limited by the number of households and by their purchasing power. Whether it concerns water heaters, refrigerators, heating or cooling systems, improvements to productivity can be obtained only if the market were expanded beyond the geographic boundaries of Tunisia. In fact, after the starting liberalization of trade between North African countries, imports of cheaper, good quality appliances from Libya already present serious competition for local manufacturers.

3.64 Finally, although technical audits of local enterprises could be undertaken in the hope of improving productivity, they are unlikely to prove of much benefit. An audit can be very useful for public enterprises, where technology and incentives for innovation are limited; it is less useful for companies who manufacture under licensing agreements with technical assistance from

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45/ Since field work completion of this Study, some progress has been made in that respect; thus, the INNORPI has prepared methods for measuring the performance of several types of household electric appliances, including ranges and ovens, fans, water heaters, washing machines and others. Also, several existing norms have now been homologated.

top European manufacturers. It would be all the more helpful to make marginal improvements in the choice of components, organization of production and management. The main problem remains the economic viability of industries operating in a tight market. Survival of these industries depends on a certain level of protection vis-à-vis imports.

Installation Constraints

3.65 Household appliances are marketed by distributors, wholesalers and/or retailers, 46/ who provide service after purchase. Good quality servicing of appliances is relatively easy, as there are not many different models on the market. However, distributors generally do not install household appliances.

3.66 Installing household appliances is performed by plumber/heating technicians and by electricians. Approximately thirty companies currently perform complex installations, such as central heating and air conditioning in tertiary sector buildings. These companies often combine the work of both plumber and electrician. The other companies are very small in size (less than five employees).

3.67 Installers are not sufficiently regulated (especially in the artisanal sector), so that technical qualifications are variable from one company to another. With the development of electricity and natural gas use, safety requirements for installations are strongly needed. For now, installers are not required to be licensed or have special training in safety standards for electricity and gas. In addition, there is no regulatory procedure for verifying internal installations.

Institutional Arrangements

Lack of Adequate Data

3.68 The lack of adequate, reliable data bases charting past and present activity in the residential and tertiary sectors has been discussed in the preceding chapters. Also, the situation is characterized by a lack of coordination among organizations such as the AME, STEG, the petroleum distributors and the INS, in the preparation of surveys, polls and other data collection activities. Finally, it should be noted that AME does not have a division which truly specializes in designing and organizing surveys and polls and in processing data.

3.69 These deficiencies related to data and coordination lead to each organization tending to use its own data, which can vary significantly from one agency to another. This brings about obvious difficulties in establishing with any precision sectoral energy balances which correspond not only with one another, but also with the global energy balance. Still, these sectoral balances are indispensable prerequisites for planning all strategies and investments. The recently created National Energy Observatory (ONE) should improve the situation through the use of existing

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46/ Approximately 1200 distributors are affiliated with the UTICA and are represented by several trade unions based on the type of product. Distribution margins, fixed by decree at the Ministry of Commerce, are divided between wholesalers and retailers.

"institutionalized" surveys (STEG, INS, etc) and the implementation of specific polls/surveys and targeted marketing studies.

Standards and Regulatory Measures Requirements and Constraints

3.70 The Tunisian Government, in particular through the work of the INNORPI, has started implementing standards for household appliances. Standards based on international norms have already been implemented for incandescent and fluorescent lights and refrigerators, and are being elaborated for other appliances, with the exception of water heaters, space heaters and cookstoves. In addition, although certification is underway (lights, refrigerators, washing machines), no certificate verifying conformity with standards has been granted, as there are no laboratories with the appropriate testing facilities.

3.71 Implementation of standards could have an impact on the energy performance of appliances by eliminating low-performance equipment from the market (refrigerators for example). In Tunisia, this impact would be limited, however, given the similarities between appliances made in Tunisia and European models, which in theory are subject to standards with strict energy efficiency requirements.

3.72 The other sphere affected by inadequate regulation and standardization is building construction. Construction is subject to several technical regulations, mainly affecting safety and material quality, but at present there are no thermal regulations. Thus, errors can result if residential and tertiary sector buildings are not designed according to the Mediterranean climate requirements for thermal efficiency. Actually, energy audits in the tertiary sector have identified a substantial potential for savings attainable by insulating buildings. The audits also show that heating and cooling systems often are over-sized relative to the building's requirements. Finally, it should be noted that architects do not have measuring instruments or software to test the thermal impacts of various construction design options.

Limitations of Mandatory Energy Audits

3.73 Current legislation requires that all tertiary sector establishments consuming more than 500 TOE annually be audited. Sixty-three establishments fall in this category (hotels, hospitals, administrative buildings). Nearly thirty establishments have been visited by experts performing simple energy audits. Only a dozen in-depth audits and full feasibility studies have been performed to date. In addition, program contracts offered to the clients outline the financial benefits offered by AME in exchange for their investment commitment. These benefits are the following:

(a) Audits are financed at 50%, with a ceiling of TD 5000; in-depth feasibility studies are financed at 50%, with a ceiling of TD 20,000; training financed at 50%, with a ceiling of TD 20,000.

(b) For implementation of audit recommendations, bank loans can be obtained at 7% instead of about 13% (for most regular loans in the sector); and bilateral cooperation agreements can provide additional access to low-interest credit. 47/

(c) Some equipment, such as solar water heaters, have special financing arrangements 48/, especially for hotels, hospitals, pools, and sports complexes.

3.74 However, although the legislation currently is in effect, only a handful of the required audits have been carried out. In addition, the financial benefits have not had the anticipated incentive effect; only three energy saving program contracts have been signed with hotels (as opposed to seven signed with industries). Thus, few energy conservation investments have been realized, which require significant external expenditures for the establishment. The most important energy management activity achieved in the tertiary sector thus remains the conversion to natural gas.

3.75 Defining and promoting innovative financing mechanisms would help to effectively implement energy saving programs that have been identified through the audits and were not implemented. Third-party financing programs involving the energy service firms and the private sector could probably be set up (provided adequate measuring and sharing of achieved savings are defined) and encouraged by Government support through financial incentives, technical and promotional assistance and loan guarantees. Utility financing programs could also be devised (loans, rebates); however, this requires that the regulatory framework as well as the tariff structure and fixing allow the utility to recover the costs of such programs.

Communication Constraints

3.76 Since its creation, AME has led four large publicity campaigns with diverse themes ranging from household appliances to transportation. The message for household appliances basically concerned choice and usage. About 150,000 fliers were produced and distributed through STEG, in mailings with bills or by its district offices. The messages were designed by AME in collaboration with the producers. Interviews with numerous professionals as well as contacts with the general public show that AME is well-known because of its public relations actions, especially its television spots.

3.77 It is important to note, however, that social marketing is still new in Tunisia. Past communications have been rather didactic and authoritarian in tone; television commercials were introduced only recently. Use of modern communication methods thus is relatively new in Tunisia, and it has yet to be improved in legal, technical or aesthetical terms. In addition, the target audiences still are not well known: there have been no studies to categorize them according to socio-cultural, socio-economic or geographic groups, and it is difficult to identify leverage groups. Finally, the general public has only just discovered marketing tools such as publicity spots, and it seems that audiences are taken in by their novelty without any guarantee that they really receive the message.

47/ A special revolving credit fund is planned, but has not yet been implemented.

48/ Also, some components will eventually be exempted from import tariffs, such as fluo-compact lamps and flow controllers. A list of exempted items is being prepared (see a suggested list in Annex 15).

IV. ENERGY MANAGEMENT STRATEGY IN THE RESIDENTIAL AND TERTIARY SECTORS

Objectives

4.1 In order to tackle the problems described in the previous Chapter, the strategy should pursue the following specific objectives, which are incorporated in the development objectives described in Chapter I:

(a) better management of wood resources, by reducing unmonitored exploitation, conserving wood where possible and necessary, and rationally developing resources wherever potential is sufficient;

(b) conserve hydrocarbons and electricity by encouraging the use of more efficient energy appliances and distribution systems;

(c) encourage use of substitution fuels which are most economic for both the consumer and the public at large, in order to slow demand for higher cost fuels;

(d) limit heating and air conditioning requirements in buildings; and,

(e) strengthen AME capacity for statistical data collecting and processing in the residential and tertiary sectors.

Strategy Components

Contents

4.2 In order to achieve the objectives outlined above, several strategy elements are proposed which take into account the constraints in each sector, as discussed in the previous chapter. The proposed energy management strategy for the residential and tertiary sectors comprise seven action programs as follows:

(a) rational management of wood energy resources;

(b) energy conservation in the residential sector;

(c) energy conservation in the tertiary sector;

(d) development of kerosene for cooking;

(e) development of natural gas in the residential and tertiary sectors;

(f) building design adapted to the climate; and

(g) institutional support.

Detailed descriptions of the programs are given in Annex 1.

Rational Management of Wood Energy Resources

4.3 Currently, rational use of wood resources has been hindered by insufficient information concerning the biomass resource base and by poorly monitored forest exploitation. The feasibility of disseminating simple improved stoves and more efficient carbonization techniques appears very limited. Areas in which wood conservation appear achievable are cooking tabouna bread and certain applications in the tertiary sector, such as water heating in Moorish baths. Also, there is probably a market for modern wood stoves in rural areas where petroleum product supply is difficult and wood is the least-cost solution.

4.4 As a result, the strategic options which constitute the action program for rational management of wood energy resources are:

(a) improve regulation (including tenurial aspects) and the existing fiscal system, and strengthen control of charcoal production and marketing to better monitor charcoal supply 49/. Forestry exploitation thus will be encouraged in areas where wood potential is most favorable and offtake limited to the real regenerative capacity of the resource. In the zones that are the most at risk, reforestation actions would probably be also needed;

(b) study the feasibility of conserving wood used in cooking tabouna bread and in certain tertiary activities such as Moorish baths; and

(c) study the market for modern wood-fired appliances in order to improve fuelwood's image, facilitate rational exploitation of local wood resources in areas where it is abundant (North West and Sahel regions), and slow substitution by imported energy 50/.

Energy Conservation in the Residential and Tertiary Sectors

4.5 The conservation potential for hydrocarbons and electricity in the residential and tertiary sectors is mixed. In the residential sector, the household appliances currently available on the Tunisian market are generally energy efficient, and the possibilities for further reducing specific consumption are marginal. Quality and performance standards for appliances are being implemented but, at present, they are insufficiently developed to either guarantee future energy

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49/ The DGF is currently planning to reform fiscal and control aspects of woodfuel production and transport through a decree to complement the Forestry Law that was enacted in 1988.

50/ Actions to promote improved or modern wood-fired appliances should build on the results obtained by AME's GTZ-supported Special Energy Program (see Annex 19).

performance or guide consumer and manufacturers' choices. There is a rather substantial energy savings potential in tertiary sector establishments; exploitation of this potential is not yet well advanced, however. The strategy elements of the action plan to address this situation are:

(a) set up a regulation and certification system to guarantee energy efficiency of household appliances, and to inform and make consumers and merchants aware of the specific consumption of the appliances that they purchase or sell 51/; and

(b) strengthen and support the program contract procedure with implementing agencies in order to stimulate energy conservation investments in new establishments of the tertiary sector.

4.6 The first element will be implemented under the energy conservation program in the residential sector. This program includes components for monitoring energy demand in households; for regulation, standardization, and labelling of household appliances; for training and licensing installers; for consumers' information campaigns on more efficient equipment and Government measures; and for negotiations with household appliance manufacturers.

4.7 The second element will be implemented under the energy conservation program in the tertiary sector. This program will mostly be beneficial to larger tertiary sector establishments. In addition to using program contracts to more closely link preliminary studies (diagnosis, detailed audits) with investments, the program also includes support in the form of financing organization, technical assistance, information dissemination and training and licensing of installers.

Development of Kerosene, Natural Gas and Photovoltaics

4.8 Kerosene and natural gas have been targeted as more cost-effective substitution energy sources. The current substitution of kerosene--a locally produced, inexpensive fuel--by LPG is not economically rational. The inferior quality of the kerosene cookers used in Tunisia partially accounts for this phenomenon. Natural gas is also a relatively cost-effective fuel, but its penetration in the residential sector has been especially slow due to high initial connection costs and lack of information for consumers. Actions also are being undertaken to develop use of solar energy, especially photovoltaic systems. The strategy elements to develop use of more cost-effective substitution energy sources are:

(a) develop and market modern kerosene cookers which offer greater convenience and energy efficiency so as to reduce switching to imported LPG;

(b) implement additional incentive measures and provide customers with greater information to encourage natural gas penetration in the residential and tertiary sectors;

51/ To that effect, the data bank created by AME's DURE on energy-efficient equipment in the tertiary sector will be very useful.

(c) pursue ongoing programs and projects for solar water heaters and assess the market of decentralized photovoltaic systems.

4.9 The first element will be implemented as part of the kerosene development program. This program includes an in-depth market study for kerosene cookers and the local manufacturing possibilities, as well as support operations to influence use of the cookers: incentive policies (fiscal aspects, fuel prices and stove prices), promotion campaigns aimed at consumers, and information for manufacturing and distribution professionals.

4.10 The second element will be implemented under the natural gas development program for the residential and tertiary sectors. This program already is a priority for STEG, as it is an integral part of the utility's plans for developing natural gas use for electricity generation and in industry. The program proposed in this report is limited to recommendations for market studies and promotion campaigns.

4.11 Current incentive policies for solar water heaters are justified and well adapted and should suffice for continuing development in the use of this technology. Concerning photovoltaics, which is a viable option for decentralized rural electrification, the scope of its potential market has yet to be estimated accurately. Current trials using small individual generators, (AME/GTZ project) will allow to better discern the market and to develop low cost, technically viable systems which meet consumer needs. 52/ In addition, it will be important to evaluate accurately households' needs, their reactions to proposed products, their sensitivity to product prices and their real ability to pay all or part of associated costs. Finally, it also will be important to consider distribution and maintenance aspects, which could present difficulties in dispersed rural areas far from main urban centers. While building on the results of the AME/GTZ project, a global assessment of the market for photovoltaic systems is necessary, as well as the identification of adequate strategies to foster its development.

Efficient Building Design

4.12 At present, little has been done to meet the objective of reducing heating and cooling requirements for buildings. No in-depth studies of the thermal quality of construction in Tunisia have been undertaken. There are no thermal regulations, and principles of design adapted to the climate which affect heating and cooling systems are not always rigorously applied.

4.13 Thus, design and construction regulations are sorely needed; their implementation is the objective of the program for adapted building design. This program has four components: bio-climatic urbanism, design specifications or codes, material selection, and design of energy equipment. Also included in the program are: research on conditions for comfort and on design rules, specification of standards and labelling methods for buildings and heating/cooling equipment, as well as design and dissemination of technical documents for professionals. The program will

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52/ According to surveys carried in the Kef region, where about 15,000 households will not have electricity during the next ten years (out of 250,000 households in such a situation at national level) and where the AME/GTZ Project has installed and monitored photovoltaic systems in 90 households, it was found that between 30 and 50% of these households have energy-related expenditure (lighting, radio, television) equivalent to the amortized cost of photovoltaic systems (about DT15 per month).

coordinate with and complement the regional EC-funded study on Thermal Analysis and Efficient Building Design in Maghreb countries, which has been launched recently (see paragraph 1.36).

Institutional Strengthening

4.14 Institutional support for AME is planned as the seventh component of the strategy. A better understanding of the residential and tertiary sectors is needed, especially the energy usage patterns in households (about which there is little information) and the structure of consumption in different tertiary subsectors. This will allow better coordination between the components of the Strategy. The support mainly comprises implementation of a data base, complementary surveys of the residential and tertiary sectors, and monitoring and possible reorientation of the different action programs. Training in the above aspects will be supplied to AME staff involved in the implementation of the strategy's components.

Regulations, Taxes and Tariffs

4.15 Regulations, Norms and Standards. The energy conservation program provides a component for implementing norms and standards, in order to cover all household appliances to improve their energy performance. Implementation of standard specifications will encourage manufacturers to monitor closely quality control and equipment performance, provided inspections by designated agencies and certification procedures are carried out scrupulously. This will require that the resources of the national laboratories be strengthened.

4.16 The program for efficient building design (building code) also provides for regulatory measures in the form of specifications or certification seals used to classify new and existing buildings according to their adaptation to the climate. First, a method for measuring "adaptability" will be needed to produce an assessment of the existing building stock, to evaluate recent public programs, and to analyze construction projects. This method will allow to: (a) define rules to be proposed to contractors and the conditions for issuing certification seals--once issued, a seal would provide access to certain benefits (special financing, exemptions from customs duties for certain equipment or material, etc.); (b) develop training and research modules; and (c) design information brochures for implementing agencies.

4.17 Without trying to make all construction uniform, the procedures for granting certification seals, building permits and financial assistance should be linked in order to avoid aberrations in design and construction. Nor is the intention to recapture the thermal attributes of older dwellings, the design of which would be close to optimum but too costly to duplicate. Rather, the objective is to produce a dwelling which maintains thermal performance compatible with the climate and preserves cultural references important to the designer, while taking advantage of technological progress. Standards or certification seals should be based on known technical principles: alignment and orientation, protection from solar radiation or--on the contrary--its judicious use during the winter, wall insulation, use of passive thermal walls, window design, use of natural ventilation, etc. The rules and their application should be understood by designers and by users.

4.18 Taxes and Pricing. A dialogue exists between appliance manufacturers and the Government related to tax constraints and customs duties imposed on industry. This dialogue is

likely to highlight the need for studies concerning Tunisian enterprises' accessibility to technology, ex-factory production costs, or markets and production strategies in neighboring countries. Based on the multiple contacts with enterprises during the Study, there appear to be no pressing needs for specific studies at the moment.

4.19 If the dialogue between manufacturers and the Government were to be enhanced, however, it could be possible to negotiate an agreement with some of the manufacturers which would allow appliances to be marketed at prices lower than current retail prices. Under such an agreement, manufacturers would market lower cost appliances, complete with guarantees for quality, reliability and energy efficiency. In return, the Government would partially exempt taxes on various parts and appliances, implement necessary standards and assist in promotion campaigns.

4.20 It is difficult, however, to justify customs duties exemptions for certain household appliances other than exemptions for parts used to manufacture solar water heaters. At the most, exemptions could be made for equipment such as thermostat regulators. Nevertheless, taxes and customs duties could be differentiated by energy type or technology for a specific usage. For example, fluorescent tubes could be promoted instead of incandescent lights. Also, the use of low-efficiency or load intensive space and hot water heaters (such as instantaneous electric water heaters) could be discouraged. Annex 15 lists appliances for which partial exemption of customs duties would be advantageous 53/.

4.21 As for pricing policy for domestic fuels, current distortions should be lifted to progressively reflect economic costs, especially for LPG and kerosene. Still, any modification of domestic fuel prices must be undertaken in the context of an overall revision of hydrocarbons pricing policy, which is beyond the scope of this study.

Institutional Framework of the Strategy

4.22 Institutional Framework. The AME will be responsible for coordinating the overall energy management strategy for the residential and tertiary sectors and for supervising the implementation of five of the six programs of the strategy. The programs for the rational management of wood energy and the development of natural gas will be handled by the DGF and STEG respectively.

4.23 In order for the strategy and each of the different programs to be effective and successful, they must be consistent with both the resources AME has at its disposal and the resources which can be contributed by AME's interlocutors (implementing agencies and professionals and tradesmen). Close cooperation will be needed between AME, the organizations and the Tunisian professionals involved. To that effect, informal technical groups will be constituted inside the AME to ensure coordination between the Departments and the ONE, and ad-hoc inter-institutional committees will ensure the technical coordination of each action program.

53/ However, it should be noted that since the completion of the Study, the Government has decided to abandon the idea of partial exemption of customs duties, even for the specific appliances listed in Annex 15. Some exemptions are still granted but on a case by case basis.

4.24 Institutional Integration. The proposed strategy is consistent with the current energy sector policy's objective for rational utilization of energy. Indeed, most of the proposed activities to be implemented as part of the strategy complement ongoing actions, programs or projects:

(a) Wood resource management is one of the objectives of the Forestry Development Project executed by DGF with assistance from the FAO. The tasks proposed as part of the strategy will complement ongoing work involving forest production and studies of market potential of forestry products.

(b) The energy conservation proposals for the residential sector rest in large part on following and strengthening ongoing work concerning load management (STEG) and standardization of household appliances (INNORPI/AME). Similarly, the energy conservation program for the tertiary sector should support and strengthen activities already underway as part of other projects, and to extend them to different tertiary subsectors.

(c) With regard to natural gas, utilization of this fuel currently is a priority in the national energy policy.

(d) Implementation of a program to design buildings adapted to the climate is complementary to ongoing work and research on lodgings, which include the recent publication of a design guide by AME and several other planned activities.

Expected Results

4.25 Woodfuel management. At present, the lack of precise regional statistics for wood resource base, supply networks and consumption make it difficult to quantify the results expected for the woodfuel management component of the Strategy. However, in qualitative terms, the results are expected to lead to the:

(a) reduction of unmonitored exploitation of wood resources and improvements in the balance between fuelwood availability and wood offtake, thus limiting the degradation of natural forest formations;

(b) evaluation of the potential for saving fuelwood used for making tabouna bread and in the tertiary sector and, if justified, design and implementation of projects to exploit that potential;

(c) evaluation of the feasibility for slowing the substitution of wood by petroleum products, in areas where the wood potential is sufficient, by introducing modern, adapted wood-fired appliances and, if justified, design and implementation of an improved stove project.

4.26 Hydrocarbon and electricity conservation. The expected results pertaining to conservation of hydrocarbons and electricity, apart from improved thermal efficiency in buildings, are:

(a) after five years, savings corresponding to 1% of final energy consumption in households relative to current consumption, equivalent to 6000 TOE/year by 1996, i.e. 8000 TOE annually in terms of primary energy;

(b) after five years, savings corresponding to 5% of final energy consumption in the tertiary sector relative to current consumption, equivalent to about 12,000 TOE/year by 1996, i.e. about 20,000 TOE/year of primary energy.

4.27 Use of substitution fuels. Expected results for use of more cost effective substitution energy sources are:

(a) in 1996, an annual increase of about 30,000 consumers using kerosene for cooking in substitution for LPG, equivalent to reducing annual LPG imports by almost 5,000 TOE;

(b) in the short term, the addition of 5000 new natural gas customers in the residential sector, corresponding to an additional 2000 customers each year relative to current annual growth, and strengthened gas penetration in tertiary establishments situated in areas served by the gas network;

(d) continuation of the progressive penetration of the market for electric water heaters by solar water heaters;

(e) market assessment of individual photovoltaic systems for electrification of dispersed rural sites and, if justified, design and implementation of a project to encourage use of these systems.

4.28 Building efficiency. The expected results for limiting heating and air-conditioning requirements in estimated new buildings include:

(a) a 20% to 30% improvement in energy efficiency for new buildings;

(b) by 1996, air-conditioning needs suppressed in about 5% of new dwellings, for annual savings of 1000 TOE in primary energy;

(c) by 1996, a 10% savings on the total energy consumed for air conditioning in new tertiary sector establishments, corresponding to annual savings of about 3000 TOE in primary energy.

4.29 Institutional strenghthening. Finally, specific results also are expected for the institutional setting in order to facilitate establishing priorities and planning energy conservation actions in the residential and tertiary sectors. Implementation of coherent data bases with regular updates will allow precise monitoring of the evolution of energy consumption for the sectors. In addition the coordination between the different organizations involved should be strengthened.

4.30 Expected levels of energy savings have been evaluated by the consultant team on a rather conservative basis. In the residential, tertiary and building sector, potential energy savings

have been evaluated based on the characteristics of existing equipment and establishments, the estimated behaviours and decisions of manufacturers and users/owners, the structure and capacity of the AME and experience and results of energy management agencies in other countries (e.g. France). In the residential sector, the assumption of minimal savings equivalent to 1% of final energy demand after 5 years of strategy implementation is conservative and benefits could be much higher. In the tertiary sector, energy savings are generated primarily by the largest establishments and the target (5% of their 1991 consumption) is a reasonable target considering the limited number of these establishments, the high potential savings identified during past audits and the fact that few investments have been realized to date. Targeted energy savings in buildings are also reasonable since they concern new homes and tertiary sector establishments only (5 and 10% of electricity consumption respectively). The size of the development program for kerosene is determined by targeting only new potential LPG consumers. Finally, savings due to woodfuel management and additional natural gas development activities are not quantified yet and therefore are not taken into account in the economic analysis.

Economic Analysis

4.31 Table 4.1 summarizes the implementation costs for the various action programs (except natural gas development) proposed in the strategy. Detailed costs are presented in the Annex 1. Total implementation costs for the strategy amount to about TD 3.8 million over five years (US$ 4.2 million), 41% of which is slated for the tertiary sector energy conservation program alone. Slightly over a third of the total sum would be used to finance studies and technical assistance, one-fourth for investments, one-fifth for training and information and one-fifth for personnel and operation costs. 54/ This total sum includes US$735,000 for national costs, including salaries of the personnel assigned to the programs (from AME, STEG, DGF or other institutions) and operating costs.

4.32 Expected energy savings are estimated to total more than 32,000 TOE/year in primary energy by 1996, with cumulative savings of more than 62,000 TOE over the period 1991-1995. In addition to energy savings, there will be an economic benefit due to use of kerosene instead of LPG. In total, implementation of the proposed strategy should generate an annual cash savings for the country which will reach TD 2.9 million per year by 1996 (US$ 3.2 million), almost equivalent in one year to the total five-year cost of the programs. The net present value is estimated at about TD 0.6 million for that period, with an economic internal rate of return of 22%. Also, yearly benefits will extend far after the end of the Project.

4.33 Economic analyses of specific programs, as presented in Annex 1, show varying degrees of cost-effectiveness. The tertiary sector energy conservation program has immediate and easily recognizable results, and also generates the largest returns (almost 50%), both for the

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54/ This includes AME staff in charge of the implementation of the strategy's components. A total of 7 staff would be involved in the following activities: energy savings in the residential sector (2); energy savings in the tertiary sector (2); building design (1); kerosene promotion (1); surveys and data bank (1); while existing AME staff could take over some of these tasks (in particular energy savings in the tertiary sector, building design, and surveys and data bank), all 7 staff have been budgeted in the economic analysis of the strategy. Woodfuel management and natural gas promotion would both require 1 existing staff from the DGF and STEG. The cost of the participation of these 7 staff has been estimated with AME data.

beneficiaries (implementing agents) and for the country. On the other hand, it is unlikely that the establishments themselves will attempt any of these actions without support and incentives from the Government, as shown by the limited scope of past interventions and the moderate level of current investments. The success of this program thus is predicated upon the participation of the public sector; the program contract procedure should guarantee a good return on public sector expenditures, however.

Table 4.1: SIMPLIFIED ECONOMIC ANALYSIS OF THE STRATEGY
(in thousands of 1991 DT)

	1991	1992	1993	1994	1995	Total	%
COSTS:							
Woodfuel management	130	30				160	4
Residential energy savings	260	190	130	80	90	750	20
Tertiary energy savings	380	380	380	230	180	1,550	41
Kerosene promotion	325	205	(15)	(140)	70	445	12
Natural gas promotion	pm	pm	pm	pm	pm	pm	
Building design	205	215	75			495	13
Institutional strengthening	75	75	75	75	75	375	10
TOTAL COSTS	1,375	1,095	615	245	415	3,775	100
Including, studies	320	100	120		20	560	15
Investments	390	390	50	30	120	980	26
Technical assistance	270	250	100	70	30	720	19
Training, information	110	170	120	40	40	480	13
Advertising campaign	100		100		100	300	8
Personnel/Operation	185	185	155	105	105	735	19
BENEFITS:							
Savings (primary TOE):							
Residential		704	2,204	4,601	8,005	15,514	25
Tertiary		2,042	4,084	12,251	20,418	38,795	62
A/C + heating savings			1,500	2,800	4,000	8,300	13
S/total		2,746	7,788	19,652	32,423	62,609	100
LPG savings	498	995	1,991	3,318	4,977	11,779	
Value (in thousands DT):							
Energy savings a/		220	623	1,572	2,594	5,009	
LPG savings b/	30	60	119	199	299	707	
TOTAL BENEFITS	30	280	742	1,771	2,893	5,716	
CASH FLOW	(1,345)	(816)	97	1,526	2,477		
NPV (12%)	594						
IRR	22%						

a/ Savings valued at DT 80/TOE, price of the fuel for power generation.
b/ Difference between the economic costs of kerosene and LPG.
c/ Cost estimates and breakdown according to consultant team reports (supporting documents #9 and 13).

Source: Mission estimates, see Table 4.2, 4.3, 4.4 and 4.5. in Annex 1

4.34 The two residential sector programs--energy conservation and development of kerosene for cooking--are less favorable than the tertiary sector program. Most of the expected results hinge on changes in consumer behavior, which are difficult to predict and measure accurately. Nevertheless, concerning the energy conservation program, a mere 1% savings in household consumption will be enough to justify the public sector investments required (rate of return of almost 30%). The kerosene development program depends largely on private sector initiative and has a good rate of return (18%). Some of the activities planned as part of these programs, especially standardization of appliances and public information campaigns, are also justified for reasons other than economic returns (see impacts of the Strategy).

4.35 The magnitude of the program results for adapted building design can be evaluated properly only in the medium- to long-term. This program must be planned over a period of several years. The IRR, although significantly lower than for other programs, is still acceptable for the period under consideration (12%). However much higher than estimated IERR can be expected because the life span of a building (30 - 40 years) would extend well beyong the terminal year for the cashflow analysis. In addition, there is a certain urgency for acting in this area given, on the one hand, the absence of any current regulation and, on the other hand, the rapid development of residential and certain tertiary construction.

4.36 While the Government should finance the costs of personnel and operation (DT0.7 million over five years), external funding should be sought after for the rest of the costs (about DT3.1 million) including foreign and local expenditure. Even if it would be easier to finance the most rentable components of the strategy separately, it is better to keep an integrated approach, which allows taking into account cross-sectoral effects and financing the less rentable strategy components.

Impacts

4.37 The simplified economic analysis presented in Table 4.1 is limited to the energy costs and benefits for implementing the proposed strategy. The strategy also has positive economic and social impacts, mainly on the environment, the quality of living in households, and employment. It is difficult to quantify these additional impacts, however.

4.38 The expected environmental impacts of improving the management of wood resources were discussed previously. Obviously, these impacts can only be positive, but they cannot be quantified at present. As has been stated, insufficient data on exploitation sites and the regenerative capacity of forest resources hinders attempts to assess the actual impact of wood energy offtake on deforestation.

4.39 Implementation of the strategy also will have a positive impact in terms of improved standard of living in households. The partial reductions in customs duties and the results of the Government's dialogue with manufacturers would allow retail prices of various household appliances to be lowered. Energy conservation and the programs to develop utilization of kerosene and natural gas in the residential sector should prompt reductions in household energy expenditures.

4.40 In addition, the dialogue between the Government and manufacturers will effect an improvement in product quality and company competences. AME's public information

campaigns will keep the public better informed about AME programs, new products, and new regulations. Implementation of quality standards will furnish both consumers and professionals (merchants, installers, STEG, etc.) with safety guarantees. Training and certification of installers, especially gas systems workers, similarly will be effected. Also, the adapted building design program should bring about improved construction standards and increase the comfort of housing.

4.41 Through implementation of standards and certification seals, Tunisian products will gain a better image, even if consumers currently prefer better known foreign brands. The improved image will stimulate domestic production and, as a result, employment in the sector will improve. Similarly, the adapted building design program should create markets for new products and bolster integration of local industry in areas such as insulation materials, for example. The qualifications of construction tradesmen and companies also will be enhanced; in time, certain techniques could be developed for export to other Mediterranean countries. As for the energy conservation program in the tertiary sector, jobs will be created by developing diagnostic activities and by realizing investments in several subsectors.

4.42 Finally, implementation of the proposed strategy also should be the impetus for job creation by stimulating development of tertiary sector activity. The energy conservation and adapted building design programs will enhance company profitability by reducing their expenses and diminish operating costs in public enterprises.

Risks

4.43 The main risks of the recommended strategy are related to actual consumer's responses and efficiency of implementation. Anticipated savings could be optimistic and the rate of penetration of energy saving measures could also be too high. However, even with a decrease of 50% in yearly annual savings, the strategy is still economically sound, on a longer evaluation period though: the NPV of the Strategy would equal 0 after about 6.5 years.

4.44 Variations in international prices of petroleum products, such as the ones observed since August 1990, will benefit to the Strategy,since higher prices will mean higher benefits in absolute terms. Also, it is reasonable to assume that the current difference between the economic costs of LPG and kerosene on one hand, and between the costs of LPG and natural gas on the other hand, would not vary significantly (i.e. absolute costs would vary in parallel), which maintains the favorable prospects for the penetration of natural gas and, to a lesser extent, kerosene in the residential and tertiary sectors, provided the current distortions in the retail prices are eliminated.

4.45 If the components of the Strategy were undertaken separately, they should be classified according to their economic rentability and risk probability. The probability-weighed NPV could be used for that purpose. In a first approximation, with the same risk probability for all components, the component with higher NPV is by far the program for energy savings in the tertiary sector, followed by the program for energy savings in the residential sector and the program for kerosene promotion for cooking (see Table 4.2).

Financing

4.46 Most components of the strategy are ready for immediate implementation as soon as funds are available. Several donors are presently contributing to project financing in the residential and tertiary energy sectors, such as GTZ, CIDA, the EC, UNDP, France, and some of these could support follow-up investments; their interest in funding part or all of the strategy's components should be assessed by the Government of Tunisia. This could be achieved through preliminary contacts of relevant donors by the AME and the organization of a one-day seminar to officially present the strategy to the donor community, relevant constitutions and the private sector. After obtaining the necessary funding, the AME should prepare a detailed work program and implementation plan for each financial component of the Strategy.

Table 4.2 Economic ranking of the strategy's programs

Program	TOTAL COST (X1000 DT)	NPV (X1000 DT)	EIRR %
Woodfuel management	160	n.a.	n.a.
Residential energy conservation	750	190	29
Tertiary energy conservation	1,550	751	47
Kerosene promotion	445	62	18
Natural gas promotion	n.a	n.a	n.a
Building design	495	2	12
Institutional strengthening	375	n.a.	n.a.
Overall Strategy	3,775	594	22

ACTION PROGRAMS

This annex presents the proposed activities for each of the seven action programs, as well as resources required for implementation. A simplified economic analysis also is presented, where possible. The programs for rational management of wood energy resources and for natural gas development are integral parts of ongoing projects, the scopes of which extend beyond the residential and tertiary sector, and thus they are not as well developed in this annex as the other action programs.

Program 1
Rational Management of Wood Energy Resources

This program is to be integrated into a larger program administered by the DGF, the Forestry Development Project (FDP). The FDP covers all forestry products, timber as well as wood energy, and includes components for tree plantations, forest management, and commercialization of various wood products. The operations proposed below support the FDP wood energy activities; therefore, they do not constitute a separate program with a distinct rate of return but they are included for financing as part of the strategy.

The lack of data and basic information concerning wood energy and its link to deforestation were emphasized in previous sections of this report. Thus, in order to define an action program in the field, a number of preliminary studies appear indispensable: (a) analysis of wood resource base and supply systems; (b) possible revisions to existing regulations; (c) market potential for modern wood-fired appliances; (d) feasibility of conserving wood used in cooking tabouna bread. These preliminary studies will help define subsequent projects.

Preliminary Studies

Wood energy resource base. Wood availability and supply systems should be evaluated, with priority given to the Northern and Central East regions. 52/ More particularly, emphasis should be given to the Northwest and the Sahel, where supply potential is the greatest. The study will comprise two phases: (a) evaluation of supply potential: productivity of natural forest formations (forest as well as shrubbery) and of existing and planned plantations, wood supply from maintenance trims and replacement of fruit trees; and (b) market studies of competing commercial uses for wood: local consumption and urban markets for woodfuels in the residential, industrial and tertiary sectors, and markets for timber, cork, olive wood and crafts. Using the supply and market potentials thus established, zones can be identified as being either environmentally at risk or desirable for wood energy exploitation. In these zones, eventual other causes of environmental degradation (land clearing, grazing, etc.) should also be assessed. In the zones that are the most at risk, reforestation actions would probably be needed in addition to the improved management of forest formations and the regulatory reforms, that are described in the following paragraph.

Revisions to existing regulations. The analysis will address the issues of "right of domain" and control of charcoal marketing and production. Emphasis will be given to urban marketing. The first priority will be to update current information to explain the gap observed between controlled production and estimated consumption. Possibilities for improvement include implementation of simple, efficient and reliable systems for defining exploitation quotas, monitoring forest exploitation, and monitoring rural and urban consumption as well as the evolution of price structures for fuelwood and charcoal. The need for revisions to the current fiscal structure (taxes and stumpage fees) affecting wood fuel producers and marketers also should be studied. These

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52/ Ongoing work on forest base evaluation will be used to that effect, in particular the national inventory carried out by the DGF in the framework of the Forestry Development Project.

studies should lead to concrete recommendations for regulatory texts, tax policy and strengthened control.

Market potential for modern wood-fired appliance. The market study for modern wood-fired appliances will test European and North American models, such as multi-purpose cookstoves (cooking, heating and hot water), high efficiency wood-stoves for heating, central heating furnaces and water heaters. The study will first include a detailed analysis of household energy demand by final use in areas where wood energy is abundant. The analysis will be followed by the selection of appliances adapted to these needs and to the local situation, based on consumer expectations and purchasing power, as well as on the possibilities for technological transfer. The cost-effectiveness for both the country and households will be examined by comparing use of such appliances with LPG and kerosene alternatives. Finally, the conditions needed for successful distribution, such as improving fuelwood's negative image, would be identified. These activities will lead to concrete recommendations which could include subsequent projects.

Feasibility of improved tabouna ovens. Distribution of simple improved cookstoves has met with little success during the Study, and thus cannot lie counted as a potential means of conserving wood. However, the acceptability of an improved tabouna oven, used to cook bread, has yet to be evaluated. Preliminary tests have established a rather substantial savings potential. Also, experiments with substituting gas for wood in ovens of this type have met with success in other countries. 53/ Thus, the first step is to study the technical and economic feasibility of an improved wood- or LPG-fired tabouna, as well as the acceptability of these options in areas where wood offtake presents environmental risks, in particular in the center and the south of the country. The study could lead to concrete recommendations for a potential improved tabouna project.

Follow-up Actions

Subsequently, if the conclusions of the preliminary studies described above are favorable, specific projects could be launched at the regional level for modern wood-fired appliances and improved tabouna ovens. In the case of wood-fired appliances, this would entail implementing measures to assist opening the market, such as:

(a) incentives for consumers: premiums for reconversion to wood- fired appliances, special payment facilities for equipment purchases, etc.;

(b) incentives for tradesmen/professionals: information (exhibitions, demonstrations, documentation), training for installers, tax and customs incentives, support for local production (special investment facilities, technical assistance, etc.);

(c) promotion campaigns directed at consumers;

(d) implementation of standards and certification of appliances, consistent with

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53/ In cities of Yemen, for example, gas substitution in ovens of this type has taken place for many years.

principles adopted for other household appliances.

The steps needed to disseminate improved tabouna ovens easily could be incorporated into measures to popularize new technologies. Thus, any project of this type should be integrated into existing rural development programs. Nevertheless, if gas substitution becomes a viable option, distribution would become the responsibility of merchants operating in the rural areas and special promotion campaigns would be needed.

Implementation and Costs

The program for rational management of wood energy resources should be executed by DGF and closely coordinated with ongoing FDP activities (while being separated from these activities which are already defined). DGF and AME should cooperate on collecting data related to wood energy supply and consumption and, possibly, associated marketing networks. AME's participation will ensure that charcoal and fuelwood are included in future national energy balances, as well as in sectoral energy balances covering the residential, industrial and tertiary sectors.

Preliminary studies of wood energy supply and evaluation of possible revisions to the regulatory framework are part of the ongoing FDP activities and are not costed here. However, a specific survey of woodfuel consumption in the residential and tertiary sectors is needed. This survey should take into account the population sample, methodology and results of STEG's 1989 survey. A total TD 40,000 is budgeted to cover the services of a household energy survey specialist (3 to 4 weeks), the surveyors' salaries and logistical expenses. Data entry and processing would be performed by AME.

The marketing study for modern wood-fired appliances will be carried out in cooperation with AME and could be administered by the Industrial Promotion Agency (Agence de Promotion de l'Industrie). The study will be limited to areas identified as having favorable potential according to the analysis of wood energy supply consumption and the household survey. A total TD 20,000 is budgeted.

The feasibility study for conserving wood used in cooking tabouna bread will consist of developing improved tabouna and gas tabouna ovens, as well as carrying out socio-economic studies to test acceptability among potential users. A total TD 40,000 is budgeted to cover the services of an improved stoves specialist (4 weeks) and a Tunisian sociologist (4 weeks) and the expenses of perfecting and testing the models.

Program 2
Energy Conservation in the Residential Sector

Proposed Actions

The proposed actions encompass the manufacture, purchase and use of electric household appliances. The targeted clients are:

(a) the general public, with the goal of developing users' energy awareness so that consumption is reduced through rational use of equipment, and to encourage households to make energy consumption a criteria when purchasing new equipment: choice of high performance equipment and brands, equipment size adapted to household needs;

(b) the tradesmen/professionals--manufacturers, distributors and importers--to encourage them to promote high performance appliances; and installers, who often advise the users.

The program will include the following actions: (a) electricity load management; (b) regulating standards and certification; (c) training and licensing of professionals; (d) information campaigns and (e) agreements with manufacturers.

Electricity Load Management. As a result of detailed analysis of marginal costs, STEG already has raised hot water tariffs to more closely match the general tariff. However, in order to contribute to limiting peak demand, it is advisable to maintain double metering and remote controlled circuit breakers for hot water heaters, which are optimal technical solutions with low maintenance costs.

Continuation of STEG's demand management activities will require close cooperation with AME and ONE in at least two areas: (i) monitoring and updating statistical balances showing consistent data for levels of household equipment, population figures, nominal consumption of appliances (as given by the manufacturers and measured by standardized methods), and total consumption by energy source; and (ii) classification of households according to homogeneous behavioral categories. The latter will allow authorities to evaluate each category's contribution to peak load. Therefore, it is imperative that AME and STEG use the same data, based partially on STEG's sales statistics, to ensure consistency with the general and sectoral energy balances. Hopefully, AME and STEG will undertake some joint analyses based on these data.

Regulation, Standards, and Certification. INNORPI should give priority to gas appliances in its activities to implement standards. In addition to applying international standards mainly related to safety, specific Tunisian standards should be defined related to the appliance's adaptation to its function.

The resources of the national laboratories will have to be reinforced so that new standards and certification of equipment can be implemented. In particular, testing benches are needed for gas water and space heaters, as well as for all cooking equipment. Testing benches for most of the other appliances (essentially lighting and refrigeration) mostly are complete. Standard specifications for television sets have least priority.

Once the standards have been established, "standardized" measures of energy consumption can be used to compare the different appliances on the market. AME then could publish a list of brands and models with their consumption statistics, which would also will be posted at sales places, in exhibition halls for wholesalers, or in retail establishments. The standardized consumption also will be indicated on labels with a seal of certification indicating conformity with standards, for appliances which so qualify. Posting energy consumption figures could be made mandatory by decree. Finally, once application of standards is well underway, they will be incorporated into a public information campaign as described below.

If standardization procedures prove inadequate for improving the energy performance of household appliances, AME could create a parallel "high performance" certification to distinguish the most energy efficient equipment. However, this does not appear to be a short-term priority.

Training and Licensing of Professionals. With the increased use of natural gas in homes and the associated safety concerns, it would be necessary to require certification of the qualifications of workers who install gas networks and appliances, and to train them. This certification requirement potentially would cover electricians as well as heating technicians. Technical certification would be granted by a technical commission composed of representatives from both professions and placed under the responsibility of a public sector agency. The workers' qualifications would be validated by a professional card and possibly by a sign or placard. In order to qualify for certification, the installer will have to (i) undergo special training covering natural gas equipment used in buildings and dwellings and (ii) prove his ability to perform state-of-the-art installations.

The distributors' principal obligation will be to post the standardized characteristics of appliances and their energy consumption. However, wholesalers also are expected to enhance consumer information by updating the detailed utilization notices, as well as by training installers of new appliances (particularly gas). Seminars will be organized for wholesalers and distributors to cover subjects such as information campaigns, standards, and posting consumption.

Information Campaigns. Information campaigns will be necessary to inform consumers of the various measures implemented by the public authorities: (a) standards and certification of equipment manufactured in Tunisia; (b) mandatory posting of consumption characteristics; (c) distribution of comparative consumption tables; (d) possible tariff modifications and tax exemptions for some equipment or uses; (e) measures to encourage specific equipment or usages, such as more efficient lights and (f) mandatory qualification and certification of installers.

The second objective will be to influence consumer behavior related to using household appliances rationally. This type of campaign necessarily must be preceded by qualitative studies to analyze current behavior, to identify the stimulus points upon which one can act, and thus to define messages which positively could influence behavior.

A third objective will be to promote specific energy sources or innovative equipment such as low consumption light bulbs or fluorescent tubes to substitute incandescent lamps, and solar water heaters. Here also the campaign should be prepared by analyses of consumer motivations and expectations in order to identify criteria other than simple economic rationality which influence the customer.

Agreements with Manufacturers. AME and other public organizations should make contractual agreements with manufacturers or groups of manufacturers, through their professional organizations, for promoting innovative solutions on energy conservation and substitution between energy sources and equipment. The main objectives of these agreements will be to improve equipment efficiency, to guarantee a certain level of quality, and/or to lower the retail price. Examples cited here are solar water heaters or promoting energy saving refrigerators.

Implementation

The priority actions for implementation in the program are:

(a) process the results of STEG's 1989 household energy survey;

(b) define and apply norms and standards for refrigerators, gas water and space heaters, and install testing equipment in approved laboratories;

(c) prepare a licensing procedure and training program for installers;

(d) identify need for further qualitative analysis of consumer behavior to round out the results of the STEG survey, and to better implement new information campaigns;

(e) set forth the dialogue and agreements with manufacturers and identify related technical assistance needs.

In order to track and analyze demand in the residential sector, close cooperation will be required between AME and energy producers (in particular STEG), as well as with all the organizations which keep household data: INS, Ministry of Civil Works, etc. Within AME, the work will be carried out by DEEP in liaison with ONE. ONE will handle regular and repetitive tasks, including managing and annually updating data bases. Its role will be to collect and process sales data from STEG and the oil companies. ONE also will monitor the consistency of demand statistics with general data from balances. DEEP's role will be to synthesize existing information in order to observe the characteristics and evolution of demand, to evaluate the determinants of demand, and to identify the need for complementary data to be obtained from surveys. After these analyses are completed, DEEP will identify the need for revisions to AME's interventions in the residential sector and propose new intervention programs.

Standards will be defined and implemented by technical commissions coordinated by INNORPI and composed of representatives from all the vocations and professions and from AME. AME will cooperate with the distributors and with the unit responsible for consumer protection within the Environmental and Quality Control Directorate of the MEN to see that the standardized consumption statistics are properly posted and to publish appliance lists with consumption figures.

Certification of qualified electric and natural gas installers will be granted by the relevant ministries in conjunction with UTICA. AME, together with STEG, will lend technical support for organizing training seminars.

The information campaigns will be implemented by AME and should be designed as a dialogue between AME and individual consumers. Therefore, it is imperative to continuously sound out the Tunisian consumers and to make preliminary marketing analyses to evaluate

consumer behavior and motivations. AME will engage a specialized agency to design and coordinate communications actions. It also is important to periodically verify the messages' effectiveness by surveying or interviewing representative consumer samples. As in the past, AME could depend on STEG and other professionals--manufacturers, distributors and installers--for distributing fliers or technical brochures.

The manufacturers and their professional organizations naturally will be AME's principal interlocutors for negotiating and establishing contractual agreements. AME will act in coordination with the Direction de la Maîtrise de la Technologie et des Mutations Industrielles (Directorate for Technical and Industrial Innovation--Ministry of Industry) and with the Industrial Promotion Agency.

Economic Analysis

Costs. The costs of the program, estimated in Table 4.2, represent a total cost of TD 750,000 discounted over five years, equivalent to US$ 820,000. They cover the following components:

(a) monitoring demand: technical assistance to establish sectoral energy balances and a household data base, forecasting methods, and support for conducting and processing surveys;

(b) norms and standards: acquire testing benches to complete existing equipment in approved laboratories;

(c) certification of professionals: financing for training installers to qualify for certification;

(d) public information campaigns: financing for preliminary behavioral analyses, preparing and carrying out two or three campaigns using different media sources;

(e) contractual agreements with household appliance manufacturers: technical support by experts (process, technology selection, organization, management, etc.), promotion of new products and support for elaborating an industrial strategy for the main enterprises.

Table 4.2: PROGRAM OF ENERGY SAVINGS IN THE RESIDENTIAL SECTOR - ECONOMIC ANALYSIS

(in thousands of DT)

	1991	1992	1993	1994	1995	Total	
COSTS:							%
Demand monitoring	40	30				70	9
Norms	50	50				100	13
Licensing of professionals	30	30				60	8
Advertising campaigns	50		50		50	150	20
Agreements with manufacture	50	40	40	40		170	23
Personnel/Operation	40	40	40	40	40	200	27
S/total costs	260	190	130	80	90	750	100
Including, studies						0	0
Investments	50	50				100	13
Technical assistance	90	70	40	40		240	32
Training, information	30	30				60	8
Advertising campaigns	50		50		50	150	20
Personnel/Operation	40	40	40	40	40	200	27
SECTORAL CONSUMPTION a/ : (x 1,000 TOE)	674	704	735	767	800		
Including, petro. products	414	431	448	466	484		
Electricity (primary)	260	273	287	301	316		
BENEFITS:							
Achieved savings		0.1%	0.3%	0.6%	1.0%		
i.e., in TOE		704	2,204	4,601	8,005	15,513	
Value in thousands DT b/		56	176	368	640	1,241	
CASH FLOW	(260)	134	46	288	550		
NPV (12%)	190						
IRR	29%						

a/ Forecast consumption of primary energy according to Table 3.1
b/ Savings valued at DT 80/TOE, price of the fuel for power generation
c/ Cost estimate and breakdown according to support document No. 9.

Source: Mission estimates.

Economic Rate of Return. The magnitude of the potential for energy savings is indicated by examining the likely evolution of consumption and behavior, assuming no action is taken: (a) rapid dissemination of inefficient appliances with specific consumption substantially higher than appliances meeting standard specifications; and (b) use of appliances with excess capacity relative to needs, poor installation or utilization leading to excess consumption which could reach 20%.

Agreements with manufacturers could lead to more rapid marketing of appliances at accessible prices, thus accelerating replacement of old appliances by more efficient equipment. However, it is difficult to establish the direct link between the proposed actions and the resulting savings because these results will depend on decisions of a number of parties (households and professionals) whose response to campaigns is largely variable. Therefore, the actual realization of the energy saving objective will be difficult to measure. Conservatively, the assumption of minimal savings equivalent to 1% of final energy demand in 1995 is made for the economic analysis.

The economic rate of return for this program is evaluated based on the savings generated for the country during the period 1991-1995, estimated at 8000 TOE/year of primary non-wood energy by 1996. Given the progressive nature of the savings generated, this target figure corresponds to cumulative savings over the period of over 15,000 TOE. Valued at TD 80/TOE (the price of fuel for power stations), this represents TD 1.2 million in savings for the country. Table 4.2 shows that the public sector investment of TD 750,000 thus will amply recovered over the period by the benefits gained. The economic IRR is close to 30%.

Program 3
Energy Conservation in the Tertiary Sector

Proposed Actions

All proposed actions in the existing tertiary sector are aimed at inducing property managers, implementing agencies and other responsible agents to carry out the investment recommended in the audits conducted to date. They also are aimed at identifying new investment opportunities.

Support for AME will include bolstering the existing procedures for establishing agreements with tertiary sector establishments. The program contracts are an excellent approach for encouraging establishments to invest in energy management. Still, preliminary studies and investments should be more closely linked in the future by proposing program contracts before the audit to formally commit both parties: (a) the private sector's commitment will be to carry out the recommendations of in-depth audits, and (b) the authorities' commitment will be to offer attractive financing options and to provide necessary information, technical and training support.

Thus, it will be important from the beginning to better discern the needs and priorities of owners/property managers, as well as their decision process for investments. The private partners should realize the full extent of the benefits and support they can expect from the public authorities both during the audits and during implementation of the recommendations. The program contracts will affect not only individual tertiary establishments, but also can be negotiated to involve joint ventures in the public or private sector.

In addition to assistance for preliminary studies and financing investments, tertiary sector establishments will need technical assistance to establish energy accounting systems and to plan and supervise adequate maintenance procedures for energy equipment (e.g. preventive maintenance). Also, successful conservation operations should be used in publicity dossiers to encourage participation by other establishments. Public sector support for private sector investments will include: (a) technical documentation; (b) organization of training seminars and sessions; (c) establishment of norms and standards for locally manufactured equipment and (d) lists of energy conservation equipment and equipment qualifying for reduced customs duties. The program will also include a component for training and licensing of professionals (installers), such as the one described in Program 2.

The types of potential interventions in smaller tertiary sector establishments fall somewhere between those planned for larger establishments and actions aimed at the public at large. They could include: distribution of simple guides explaining the principles of energy accounting adapted to small businesses and giving ratios linking consumption to surface area, to number of appliances/equipment and to number of lighting fixtures; technical assistance on demand analysis; and assistance for pre-distribution of some equipment. Interventions of this type already have been carried out by AME in bakeries (industrial sector. according to INS classification).

Implementation

The energy management program for the tertiary sector should give priority to larger establishments for the following reasons: (i) they account for most of potential energy savings; (ii) interventions are facilitated by the relatively limited number of establishments, thus increasing impact of action by the public authorities; and (iii) AME's resources are limited. Priority sectors are hotels, hospitals, office buildings (public or private), municipalities and Turkish baths. Other tertiary subsectors like cafes, restaurants or commerce represent less important savings potentials.

In order to work with private as well as public property managers, the AME will rely on organizations which must be able to be co-sponsor of some of the actions and to assist in distributing documentation or organizing training. In addition to STEG, these parties will be:

(a) the supervising ministries, notably for the new programs for constructing buildings or office parks; for hospitals and other health establishments, AME will rely on the central technical services of the Ministry of Health;

(b) the municipalities or town councils managing a large number of buildings: this sector is already targeted under an integrated program requiring that "energy specialists" be trained in several municipalities; and

(c) the professional unions such as UTICA or the chambers of commerce in subsectors composed of a substantial number of small businesses.

The AME also will have recourse to energy sector professionals: thermal engineers, consulting firms, installers. In effect, these professionals play an intermediary role with public authorities and ensure the actual promotion of energy management in the field. Specialized training for energy professionals could be provided under various bi-lateral or multi-lateral projects (for example, the World Bank proposed Energy Conservation and Diversification Project).

Costs and Economic Rate of Return

Costs. The costs of public sector interventions, estimated in Table 4.3. total TD 1.55 million (US$ 1.7 million) over five years. However, direct public sector investment tied to program contracts should not exceed 10% of the total investments made by property managers and implementing agencies. Thus, public sector interventions should generate energy conservation investments valued at over TD 9 million.

The public sector budgets, managed by AME, cover the following operations:

(a) the program contracts' commitment of public funds for financing part of the audits and investments; direct interventions, such as subsidies and possible soft loans are included but not the cost of possible fiscal measures;

(b) the costs of documentation, dissemination of information and demand operations

in the small tertiary sector;

(c) the costs of support actions such as training, organization of seminars and the distribution of technical documentation.

Economic Rate of Return. The energy savings potential is generated primarily by the largest establishments which represent two-thirds of the total demand in the sector. Savings equivalent to 5% of 1991 consumption are expected in 1995. This target figure is reasonable, given the high potential savings identified during the audits, and the fact that few investments have been realized to date.

An annual savings of about 11,000 TOE in final energy will be generated by 1996, corresponding to over 20,000 TOE/year in primary energy. The resulting cash savings for the country were evaluated considering primary energy savings, valued at the fuel price for power plants (TD 80/TOE). Estimates will top TD 1.6 million for the year 1995, with over TD 3 million in cumulative savings during the period 1991-1995.

The rate of return of investment for the property managers and implementing agencies usually is documented in advance by the audits and the preliminary studies. In the tertiary sector, the ratio of investments to benefits corresponds to an average payback period of two years. As for public sector investments, Table 4.3 shows that the IRR for the tertiary sector program is close to 50%.

Table 4.3 : ECONOMIC ANALYSIS PROGRAM OF ENERGY SAVINGS IN THE TERTIARY SECTOR

(in thousands of DT)

	1991	1992	1993	1994	1995	Total	%
COSTS:							
Audits, preliminary studies	100	100	100			300	19
Co-financing	150	150	150	150	100	700	45
Small tertiary	50	50	50			150	10
Support activities	40	40	40	40	40	200	13
Personnel/Operation	40	40	40	40	40	200	13
S/total public costs	380	380	380	230	180	1,550	100
Including, studies	100	100	100			300	19
Investments	150	150	150	150	100	700	45
Technical assistance	30	30	30			90	6
Training, information	60	60	60	40	40	260	17
Personnel/Operation	40	40	40	40	40	200	13
SECTORAL CONSUMPTION 1991: (x 1,000 TOE) a/	408						
Including, petroleum prod.	151						
Electricity (primary)	258						
BENEFITS:							
Achieved savings/1991		0.5%	1%	3%	5%		
i.e., in TOE		2,042	4,084	12,251	20,418	38,795	
Value in thousands of DT b/		163	327	980	1,633	3,104	
CASH FLOW	(380)	(217)	(53)	750	1,453		
NPV (12%)	751						
IRR	47%						

a/ Forest consumption of primary energy according to Table 3.2.
b/ Savings valued at DT 80/TOE, price of the fuel for power generation.
c/ Cost estimate and breakdown according to supporting document No. 9.

Source: Mission estimates

Program 4
Development of the Use of Kerosene

Proposed Actions

The projections of household consumption trends for different energy sources presented in Annex 13 indicate the market for principal household cooking fuels in the short term (Annex 16). If no action is taken to change current trends, an additional 25,000 to 30,000 households will use LPG for cooking each year. These include both new households and households which will have abandoned fuelwood or kerosene. The development program for using kerosene will target these new potential LPG consumers.

The absence of modern and efficient kerosene cookers on the Tunisian market probably is one of the factors behind households' preference for LPG. Demonstrations of South American kerosene cookers were given as part of the study. These cookers are more attractive, more convenient and more efficient than currently used pressure stoves 54/ (babours). Preliminary indications are that an untapped market for these cookers exists which could compete with gas hotplates. Present users of kerosene (about 300,000 households) would also be targeted to replace their babours by more efficient cookers (additional maximum market of about 40,000 cookers each year). The actions proposed to win this market comprise two phases. Phase one actions are to:

(a) identify adequate kerosene cookers that meet the acceptance of targeted consumers' groups (e.g. wood users in peri-urban areas and small cities) in terms of convenience, safety, cost, aspect, etc;

(b) study the market potential of identified kerosene cookers in detail: reactions of targeted consumers (in both rural and urban areas) and household appliance distributors, price sensitivity, identification of market openings and convincing sales pitches, etc.;

(c) analyze the possibilities of technological transfer and cost pricing assuming different scenarios for importing or local manufacture.

In the second phase, if the conclusions of these preliminary studies are positive, steps should be taken to open and supply the market. The interventions foreseen are:

(a) incentive measures for consumers: promotional prices, special facilities for purchasing equipment, etc.;

(b) incentive measures for professionals: information (exhibitions- demonstrations, documentation, study trips, etc.), fiscal and customs incentives, support for local

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54/ However, field tests conducted by AME's Special Energy Program in rural areas of the Kef region have revealed the low acceptance of the "Superior" stove due to concerns for safety when used with gasoline and difficulties in lighting the fire if kerosene was used (except if a significant amount of alcohol was used for this operation).

production (investment facilities, technical assistance, etc.);

(c) promotion campaigns aimed at consumers;

(d) norms, standards, and certification for cookers based on procedures defined for household appliances as part of the energy conservation program in the residential sector.

Finally, implementation of a new pricing policy for kerosene and LPG should be envisaged. Establishing retail prices based on economic costs would favor kerosene, thus modifying consumer choices. It also may be necessary to eventually revise the margins for distribution and transport to improve service to rural zones. However, the price structure of LPG and kerosene can be revised only in the context of a global revision of current pricing policy for all petroleum products, which is beyond the scope of this Strategy.

Implementation

Program implementation will be administered by AME, which can rely on the Industrial Promotion Agency to undertake the preliminary studies. The interventions for opening the market will be carried out in collaboration with household appliance distributors and their representatives, such as ImCA and the chambers of commerce. Support for professionals will include pre-financing necessary investments with low-interest loans in order to share the risks associated with the first lot of cookers placed on the market.

Costs and Economic Rate of Return

The program costs, estimated in Table 4.4 represent a total of TD 445,000 over five years. This covers financing for preliminary studies, technical assistance, training information for professionals and three promotion campaigns.

The target figure for annual sales to current and potential LPG users, (30,000 cookers), should be reached by 1996. The national benefits have been evaluated in terms of savings realized by foregoing LPG use, taking into account the differential between the economic costs of LPG and kerosene (TD 60/TOE in 1988). They should reach TD 300,000/year by the fifth year of the program, with an economic IRR of 18%.

Table 4.4 : ECONOMIC ANALYSIS OF PROMOTION OF KEROSENE FOR COOKING

(in thousands of DT)

	1991	1992	1993	1994	1995	Total	
							%
Studies:							
Market		50				50	
Manufacturing		30				30	
Evaluation				20		20	40	
S/total		80		20		20	120	27
Support to professionals							
Pre-investments		120	200			320	
			(60)	(120)	(140)		(320)	
Technical assistance		30	20			50	
Information		20	20	10		50	
S/total		170	180	(110)	(140)		100	22
Promotion campaign		50		50		50	150	34
Personnel/Operation		25	25	25			75	17
TOTAL COSTS		325	205	(15)	(140)	70	445	100
Sales target (number of units)		3,000	6,000	12,000	20,000	30,000		
Saved LPG (TOE) a/		498	995	1,991	3,318	4,977	11,779	
TOTAL BENEFITS b/		30	60	119	199	299	707	
CASH FLOW		(295)	(145)	134	339	229	262	
NPV (12%)		62						
IRR		18%						

a/ Consumption estimated at 150kg of LPG per household and per year, according to the controlled cooking tests made by the mission.

b/ Difference between the economic costs of LPG (DT 220/TOE) and kerosene (DT 160/TOE), with 1988 prices.

c/ Cost estimate and breakdown according to supporting document No. 13.

Program 5

Development of Natural Gas Use

The program for developing natural gas use in the residential and tertiary sectors cannot be disassociated from development of natural gas in other sectors of activity, in particular electric power generation and industry, because of the magnitude of investments to be realized for extending the network. This is a national energy policy issue, the scope of which largely exceeds the context of the
Strategy.

Development of natural gas in the residential and tertiary sectors, currently is one of STEG's priorities. Thus, only a few operations are proposed in this report to accompany infrastructure investments, complement ongoing actions and favor natural gas penetration. They should be administered by STEG, but could be carried out in collaboration with AME. They include:

(a) detailed evaluation of the market in the two sectors through surveys of potential consumers in order to ascertain demand levels, cost of distribution and current blockages (this evaluation should start from and develop the results of studies that have already been done by STEG); this evaluation should be done in a cross-sectoral perspective since adequate development of the residential market for natural gas is closely linked to the successful penetration of this fuel in other sectors, especially power generation and the industry; tariffs, regulatory and institutional aspects should also be carefully examined;

(b) analysis of the marginal cost-effectiveness of extending the grid to reach new zones of activity and/or neighborhoods with strong consumption potential, and analysis of the economic costs of connection;

(c) promotion campaigns for consumers to explain the advantages of natural gas, inform on its utilization and give safety guarantees;

(d) study the possibility of implementing incentives for interior distribution installations and possible replacement or reconversion of existing appliances.

Actions proposed in the context of energy conservation programs for the residential and tertiary sectors also could contribute to development of natural gas. They include standardization of gas-fired household appliances and equipment, and training and certification of qualified installers.

Program 6
Design of Buildings Adapted to the Climate

Proposed actions

The process leading to the implementation of building design specification will involve the following steps: (a) research on conditions of comfort and consideration of the rules of design adapted to the climate, (b) distribution of a guide for living quarters, (c) classification and quantification of current construction, (d) standardization and certification of buildings, and (e) standardization of energy equipment.

The criteria of comfort within premises must be defined according to the period of occupation, based on the definition of climatic references for different periods of the year and in each climatic zone (averages on several years). By carefully considering the design rules, it will be possible to maximize the contribution of solar energy in winter; to reduce it in summer; to ensure proper ventilation; to orient buildings, facades and the placement of interior walls; and to optimize the interior spaces and their forms in order to reduce thermal losses. Design issues also will include insulation of walls and ceilings, protection--or alternately exposure--of windows and material selection.

A guide for living quarters will be used to allow individuals, property managers and building owners to carry out a thermal audits themselves, or to have one done professionally. If needed, two guides could be prepared, one for individuals, the other for property managers/owners of tertiary buildings or collective residential units. AME has just completed "Technical Recommendations for Building Design". This basic document will be updated progressively with detailed technical information as and when standardization procedures advance. In addition, its contents could be summarized in schematic and illustrated leaflets for property managers/owners or individuals without the necessary technical knowledge.

Reference buildings will be chosen for technical and economic comparative analyses of current construction. Architectural practices, techniques used and the choice of material will be analyzed as representing short-term construction trends. Then, the technical and energy characteristics of reference buildings will be quantified according to the following tasks: choice of representative living modules giving rise to generalized results; accurate measures of energy consumption in representative buildings for heating and, if necessary, cooling; study of construction elements and materials; census of existing materials; cost analysis of existing buildings; analysis of the coefficient of heat transfer, solar factors and other thermal characteristics of building components; and a preliminary estimate of additional costs resulting from requiring buildings to conform with new rules.

Once a method has been elaborated for new building specifications and codes, it will be presented to building contractors during commissions' meetings, at training sessions and through dissemination of example technical options. Legal aspects of each standard and label should also be defined at that stage (e.g. optional recommendations versus mandatory codes). Also planned is elaboration of a guide for materials and components. This guide will establish a classification of the materials which can be used in Tunisia.

With regard to specifications for energy equipment, research to undertake and documents to be produced will cover lighting codes, choice of fuels, zoning and sectioning for installations, scaling of equipment, placement of heating/cooling equipment, optimization of

engineering, sizing and heat insolation of fluid circuits, the placement of heating and cooling vents, the choice of regulation equipment, and management of installations.

Implementation

The programs for designing buildings adapted to the climate will be administered by AME in collaboration with relevant ministries. Research and specific actions will be carried out in collaboration with the Ecoles Nationales d'Ingénieurs of Tunis and Monastir, the Institut Technique d'Architecture et d'Urbanisme de Tunis and the Centre Technique du Bâtiment. Testing can be done either in STEG's laboratories or those of CETIME.

Committees or commissions composed of architects, consulting firms, construction firms, and promoters should be formed so that all parties concerned with the design and implementation of the proposed actions will participate in decisions from the beginning. The participation of other parties also may be desirable, including the main public sector property managers/owners (particularly municipalities which build and/or organize and regulate construction) as well as consumers and their representatives.

The program covers dwellings and buildings with and without artificial cooling. However, priority will given to the tertiary sector and to artificially cooled buildings. The main target clients of the program are the following:

(a) public or subsidized construction (clearly identified main contractor and design by architects): the fact that construction is the responsibility of the State or local communities, or that it will receive specific assistance, is conducive to more standard-oriented and regulatory interventions;

(b) private upper-middle or upper class construction undertaken by identifiable property managers/contractors (architects, real estate societies): regulatory interventions are more difficult than in the preceding case, but it is possible to rely on the financing channels used for these buildings in order to convey regulatory requirements.

(c) other private construction; property managers and contractors are of direct interest here.

The operations proposed above could be complemented by a regional project (Maghreb countries) incorporating the following tasks: (a) collect climate data for North African countries, (b) standardize construction components which are relatively independent of the climate, (c) identify and compare the most widespread construction modes taken as references for establishing the code, (d) estimate the additional costs required for the improvements, (e) develop technical and educational software, and (f) define an approach which will allow quantification of standards or certification seals. This project would comprise research tasks as well as organization of professional exchanges between North African countries and it would coordinate with the activities of the Mediterranean Environment Plan.

Costs and Economic Rate of Return

The costs of the program, excluding the hypothetical regional project mentioned above, are presented in Table 4.5. They cover the costs of technical assistance to AME, including studies and operations carried out by Tunisian and foreign experts, as well as purchases of small

equipment (for measurement), computers and software. The total cost of the program is estimated at TD 500,000 over five years.

The expected savings related to cooling new homes are equivalent to 5% of the estimated cooling requirements for new homes which must be built in 1995: about 1000 lodgings each consuming 4,000 kWh/year or 1 TOE of primary energy. Cumulative savings thus realized would reach 1000 TOE/year in primary energy by the year 1996. In addition, savings in the tertiary sector have been estimated at 10% of the cooling requirements 55/ for new tertiary establishments in 1995, which represents approximately 3000 TOE/year in primary energy, assuming that about half the annual increase of electricity consumption is attributable to new establishments. The savings for the country have been estimated based on the fuel price for electric power plants. Table 4.5 shows that, on that basis, the economic IRR for the program is 12%.

55/ Estimated at 20% of electric power consumption in establishments, according to 1984 surveys, as cited above.

Table 4.5 : PROGRAM OF IMPROVED BUILDING DESIGN - ECONOMIC ANALYSIS

	(in thousands of DT) 1991	1992	1993	1994	1995	Total	%
COSTS:							
Comfort, design rules	40					40	8
Typology, characteristics	100	40				140	28
Building norms	20	30				50	10
Committee work		30				30	6
Implementation		10	20			30	6
Promotion of examples		20	30			50	10
Guide of materials		30				30	6
Norms for equipment	20	30				50	10
Personnel/Operation	25	25	25			75	15
S/total costs	205	215	75			495	100
Including, studies	40					40	8
Investments	50					50	10
Technical assistance	90	130				220	44
Training, information		60	50			110	22
Personnel/Operation	25	25	25			75	15
BENEFITS:							
Estimated savings a/: (in primary TOE)			1,500	2,800	4,000	8,300	
Including, residential			500	800	1,000	2,300	
Tertiary			1,000	2,000	3,000	6,000	
Value in thousands of DT b/			120	224	320		
CASH FLOW	(205)	(215)	45	224	320		
NPV (12%)	2						
IRR	12%						

a/ On water heading and air conditioning consumptions
b/ Savings valued at DT 80/TOE, price of the fuel power generation.
c/ Cost estimate and breakdown according to supporting document No. 9.

Source: Mission estimates.

Program 7
Institutional Support

Proposed Actions

The institutional support for AME, through the National Energy Observatory (ONE), will include implementation of a reliable and coherent data bank foL energy demand in the residential and tertiary sectors including woodfuels and renewable energy. 56/ Ongoing work in the residential sector, in particular the processing of data from STEG's 1989 survey, should be continued. The program for rational management of woodenergy resources involves a complementary survey of households. The program for energy conservation in the residential sector also includes components for monitoring households with electricity and their segmentation according to relevant variables, as well as establishing a data bank on household appliances.

Also, through its Directorate of Renewable Energy (DRE) and in close collaboration with STEG, the AME should carry out the Study to assess the global market of photovoltaic systems for decentralized use in households. If the results of the Study are positive, a specific program to develop the required infrastructure for the dissemination of photovoltaic systems could be implemented. A brief description of such a program is given in this Annex.

The subsectors of the tertiary sector which are still relatively unknown also should be surveyed. This would involve making a reliable count of establishments, and classifying establishments in each subsector according to equipment and energy consumption. The data base should be updated regularly and simple demand forecasting methods, developed and implemented (including software being developed by AME).

The support to AME will enhance its ability to monitor, evaluate, and revise as necessary the programs of the energy management strategy in the residential and tertiary sectors. This will involve regularly keeping track of the realization of objectives for each program and measuring the impact of measures taken, as well as following of the evolution of consumption trends and consumer segmentation.

Costs and Implementation

The cost of this support is estimated at TD 75,000/year, for a total of TD 375,000 over five years. It covers financing of short-term expertise (TD 45,000/year), surveys (surveyors and logistics) and organizing seminars.

The short-term expertise will cover (i) design, realization and processing of surveys; (ii) monitoring and evaluating program results and other ongoing activities in the two sectors concerned, and (iii) training in the above aspects. More technical expertise could also be solicited to help analyze potential energy savings in certain tertiary subsectors and to search for technical options to exploit this potential.

56/ The ONE is completing the implementation of the National Energy Information System (SINEN).

PROSPECTIVE ACTIVITY
Rural electrification through photovoltaics
Brief description

Background

It is estimated by Société Tunisienne d'Electricité et de Gaz (STEG) that by the end of the Seventh Development Plan (1987-1991) between 250,000 and 300,000 rural households will remain without access to grid electricity. Most of these households are dispersed throughout remote rural areas where the costs of grid extension would be extremely high and electricity consumption would be relatively low, generally limited to lighting, radio and television. If these households were to be connected, their electricity consumption would be insufficient to generate the revenues that would be necessary to cover the costs of grid extension and connection. Connection of these households would require considerable subsidy.

Under such circumstances, i.e. low electricity consumption by dispersed rural households, decentralized power systems such as photovoltaics are often the economically leastcost option for household power supply. An economic assessment of these systems carried out as part of ESMAP's ongoing energy efficiency study in Tunisia suggests that they are economically less costly than grid extension in cases where there are fewer than 5 to 25 low power connections (e.g. households) per kilometer of medium tension line, depending on insolation and average daily load.

A project to test and demonstrate such systems is being carried out by the Agence de Maitrise de l'Energie (AME) with the assistance of GTZ. Since June 1989, 90 individual household photovoltaic systems have been installed in the Kef region. 57/ Both one and two panel systems have been installed, capable of providing enough power for basic needs such as lighting, radio and television. These systems cost locally between DT 850 and DT 1,400 depending on the size of the load, e.g. more lamps result in a more costly system. Formal monitoring of these systems continued through March, 1990.

AME has been encouraged by the experience to date with the systems, and is considering expanding the program to cover approximately 2000 households with a mix of grant and loan financing. AME has also indicated that demonstration and testing of photovoltaic pumping systems and small wind turbines should be included in this program at additional cost. A possible source of the loan financing would be the reallocation of funds under the Power System Efficiency Improvement component of the Bank's Energy Conservation and Diversification Project, which is under preparation.

Project Objectives

The immediate objective of this activity is to develop a commercially viable infrastructure for the dissemination of technically sound household photovoltaic systems in areas

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57/ 15 establishments from the public sector (schools, border ports, etc.) have also been equipped with PV systems with up to 5 panels.

where grid extension would be economically more costly. This would support the broader development objective of the Energy Conservation and Diversification Project to reduce the cost of energy consumption in the Tunisian economy by promoting viable and highly economic investments in energy conservation and substitution.

Source of work

Conventional rural electrification typically involves substantial subsidy. In order to reduce this subsidy, and perhaps even eliminate it, the activity would aim to establish a commercially viable enterprise to undertake the marketing, distribution and maintenance of these systems. This enterprise would administer a revolving credit fund capitalized by the initial purchase of 2000 household systems. The enterprise would sell these systems for cash, or on credit; proceeds of these sales or credit payments would be used to purchase more systems which would in turn be sold to other households. Most likely, only 5 to 10% of rural households could afford these systems on a cash basis. The availability of credit schemes would increase market size; the longer the payback and lower the payments, the more households could be attracted to the program. If the Government decides that social priorities justify subsidies to increase rural penetration of these systems, loan terms could be adjusted to include indirect subsidies (e.g. lower-than-market interest rates). However, subsidization can limit system dissemination since the availability of government resources may become the binding constraint rather than affordability to households.

Although AME is responsible for the development and demonstration of alternative energy technologies, STEG involvement must also be sought to ensure that this activity complements ongoing and planned rural electrification activities.

This activity would comprise the following components:

(a) evaluation of existing household photovoltaic systems regarding both technical performance and consumer acceptability, particularly in light of the level of service demanded and the willingness and ability to pay for that service;

(b) identification of areas where such systems would be less costly than conventional grid extension;

(c) establishing technical specifications for these systems in light of the findings of (a) above (this would include portable lighting systems as well as community battery charging systems);

(d) selection of an organization, perhaps parastatal or even entirely private sector, to administer the program under AME supervision (candidates include Tunisian consumer electronics companies or SEREPT Energies Nouvelles, which currently manufactures and markets solar water heaters);

(e) procurement of 2000 systems;

(f) selection and training of local rural agents for system installation and maintenance;

(g) marketing and installation of the systems; and

(h) monitoring of dissemination and technical quality control.

Costs

The hardware cost for a program of this size would be around US$2 million. The cost of studies and technical assistance to assess the market, establish technical specifications and develop an adequate marketing infrastructure would amount to about US$200,000. Total cost of the project would be US$2.2 million.

TUNISIA: ADMINISTRATIVE DIVISIONS

Region	Government	Area km2	Area %	%
TUNIS	Tunis	346	0%	13%
	Ariana	1,558	1%	58%
	Ben Arous	761	0%	29%
	S/Total	2,665	1%	100%
NORTH EAST	Nabeul	2,788	2%	30%
	Zaghouan	2,768	2%	30%
	Bizerte	3,685	2%	40%
	S/Total	9,241	6%	100%
NORTH WEST	Beja	3,558	2%	22%
	Jendouba	3,102	2%	19%
	Kef	4,965	3%	31%
	Siliana	4,631	3%	28%
	S/Total	16,256	10%	100%
CENTER WEST	Kairouan	6,712	4%	31%
	Kasserine	8,066	5%	37%
	Sidi Bouzid	6,994	5%	32%
	S/Total	21,772	14%	100%
CENTER EAST	Sousse	2,621	2%	19%
	Monastir	1,019	1%	7%
	Madhia	2,966	2%	21%
	Sfax	7,545	5%	53%
	S/Total	14,151	10%	100%
SOUTH WEST	Gafsa	8,990	6%	25%
	Tozeur	4,719	3%	13%
	Kebili	22,084	14%	62%
	S/Total	35,793	23%	100%
SOUTH EAST	Gabes	7,175	5%	13%
	Medenine	8,588	6%	16%
	Tataouine	38,889	25%	71%
	S/Total	54,652	36%	100%
	GRAND TOTAL	154,530	100%	

DATA OF 1975 AND 1984 CENSUS
(in thousands of inhabitants)

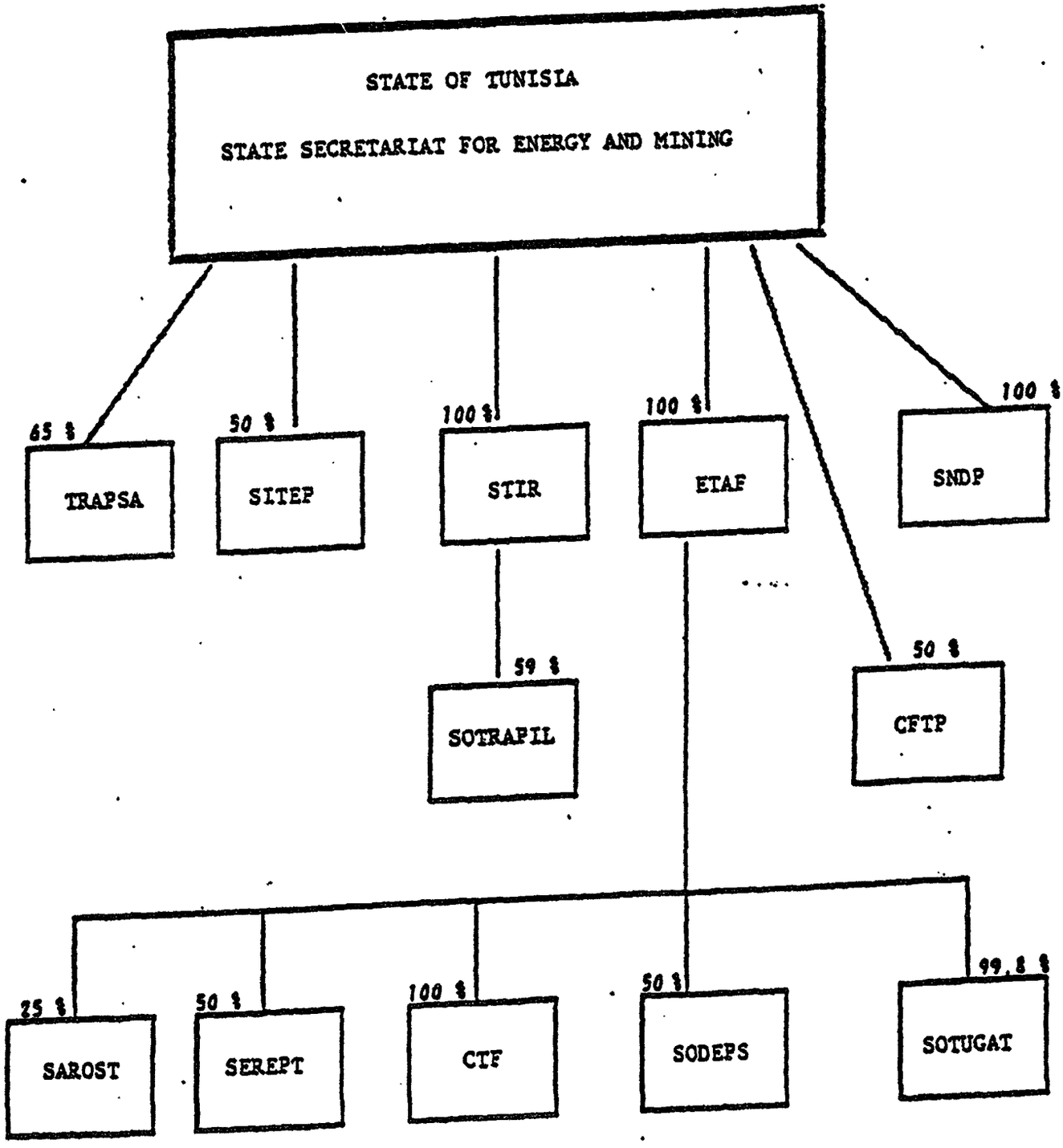
Region	Area	Population 1975 Inh.	%	%	Households	Size	Population 1984 Inh.	%	%	Households	Size	Annual Growth 1975-1984 Popu	Hous.
Tunis	Total	1,050	100%	19%	195	5.4	1,395	100%	20%	267	5.2	3.2%	3.6%
	Urban	906	86%	33%	168	5.4	1,181	85%	32%	229	5.1	3.0%	3.5%
	Rural	145	14%	5%	27	5.7	214	15%	7%	37	5.8	4.4%	3.7%
Including,	dispersed	39	4%	2%	6	6.1	68	5%	4%	11	6.1	6.3%	6.3%
North East	Total	811	100%	15%	145	5.6	975	100%	14%	178	5.5	2.1%	2.3%
	Urban	419	52%	15%	76	5.5	504	52%	14%	96	5.3	2.1%	2.5%
	Rural	391	48%	14%	69	5.7	471	48%	14%	83	5.7	2.1%	2.1%
Including,	dispersed	341	42%	18%	60	5.7	286	29%	17%	50	5.7	-1.9%	-2.0%
North West	Total	974	100%	17%	168	5.8	1,104	100%	16%	200	5.5	1.4%	2.0%
	Urban	228	23%	8%	41	5.6	291	26%	8%	54	5.4	2.7%	3.3%
	Rural	746	77%	27%	128	5.8	813	74%	25%	146	5.6	1.0%	1.5%
Including,	dispersed	422	43%	22%	74	5.7	298	27%	17%	53	5.7	-3.8%	-3.7%
Center East	Total	1,171	100%	21%	215	5.4	1,449	100%	21%	269	5.4	2.4%	2.5%
	Urban	734	63%	26%	135	5.4	895	62%	24%	178	5.0	2.2%	3.1%
	Rural	437	37%	16%	80	5.4	554	38%	17%	91	6.1	2.7%	1.4%
Including,	dispersed	294	25%	15%	49	6.0	273	19%	16%	46	6.0	-0.8%	-0.8%
Center West	Total	795	100%	14%	143	5.5	1,008	100%	14%	175	5.8	2.7%	2.3%
	Urban	135	17%	5%	24	5.5	228	23%	6%	41	5.6	6.0%	6.0%
	Rural	660	83%	24%	119	5.5	780	77%	24%	135	5.8	1.9%	1.4%
Including,	dispersed	559	70%	29%	96	5.8	602	60%	35%	103	5.8	0.8%	0.8%
South	Total	787	100%	14%	145	5.4	1,035	100%	15%	184	5.6	3.1%	2.7%
	Urban	356	45%	13%	64	5.6	582	56%	16%	103	5.6	5.6%	5.5%
	Rural	430	55%	15%	81	5.3	453	44%	14%	81	5.6	0.6%	0.0%
Including,	dispersed	260	33%	14%	47	5.5	199	19%	12%	36	5.5	-2.9%	-2.9%
Tunisie	Total	5,588	100%	100%	1,010	5.5	6,966	100%	100%	1,273	5.5	2.5%	2.6%
	Urban	2,779	50%	100%	507	5.5	3,681	53%	100%	701	5.3	3.2%	3.7%
	Rural	2,809	50%	100%	503	5.6	3,285	47%	100%	572	5.7	1.8%	1.5%
Including,	dispersed	1,915	34%	100%	333	5.8	1,725	25%	100%	299	5.8	-1.2%	-1.2%
Large Towns	Tunis	550	10%	20%			597	9%	16%			0.9%	
	Ariana	48	1%	2%			99	1%	3%			8.4%	
	Sfax	199	4%	7%			232	3%	6%			1.7%	
	Sousse	70	1%	3%			84	1%	2%			2.1%	
	Bizerte	79	1%	3%			95	1%	3%			2.0%	
	Gabes	49	1%	2%			92	1%	3%			7.4%	
	S/Total	994	18%	36%			1,197	17%	33%				
Towns >50,000		4					12						

Household = Group of persons living in the same housing, incl. bachelors but excluding collective public housing.
Urban = Counties and towns with more than 2000 inhabitants.
Dispersed = Isolated housing and village with less than 50 inhabitants.

Source: INS.

ORGANIZATION OF TUNISIA'S ENERGY SECTOR

ORGANIZATION CHART
THE HYDROCARBONS SECTOR



NATIONAL ENERGY BALANCE
1990
Unit: Ktoe

	Coal	Natural Gas	Crude Oil	Petroleum Products	Electricity Primary	Electricity Secondary	Total
1 Production		331	4612		10		4953
2 Imports	70	903	449	1935			3357
3 Exports			-3373	-527			-3900
4 Stock variations	0		77	-138			-61
Total available	70	1234	1765	1270	10	0	4349
5 Crude oil refining			-1765	1673			-92
6 Gas production		-18		116			98
7 Electricity production		-885		-353	-10	421	-827
8 Losses and discrepancies		2		18		52	74
Final consumption	70	329	0	2823	0	373	3595
9 Consumption by Sector	70	329	0	2710	0	373	3482
a) Industry	70	270		902		193	1435
b) Transport				1046		1	1047
c) Residential		38		358		81	477
d) Tertiary		21		198		79	298
e) Agriculture				206		19	225
10 Non-energy use				113			113

Source: AME - National Energy Observatory/May 1991.

FINAL ENERGY CONSUMPTION IN THE RESIDENTIAL SECTOR (1984)
(In Thousands of TOE/year)

End-use	Wood a/	Charcoal	S/total biomass		Natural gas	LPG	Kerosene	Fuel-oil & diesel	S/total pet prod		Electricity (STEG)		TOTAL	
Cooking b/	378 58%	81 12%	459 70%	90%	10 2% c/	125 19%	57 9%		192 30%	61%			652 100%	74%
Space heating	13 16%	19 24%	32 40%	6%		2 2%	22 28%	22 28%	46 58%	14%	1 1%	2%	78 100%	9%
Water heating	21 32%		21 32%	4%		20 31%	16 25%		37 56%	12%	8 12%	14%	65 100%	7%
Lighting						2 3%	41 69%		42 72%	13%	17 28%	30%	59 100%	7%
Appliances											30 100%	55%	30 100%	3%
TOTAL	411 47%	100 11%	511 58%	100%	10 1%	149 17%	136 15%	22 2%	317 36%	100%	56 6%	100%	884 100%	100%

a/ Including other biomass (agriculture residues, etc.).
b/ Including bread-cooking with wood and other biomass, tea preparation and food-grilling with charcoal.
c/ Including water and space heating.

Source: INS, STEG, Amous and Ouerghi (1986), and mission estimates.

CONSOMMATION TOTALE DES MENAGES ELECTRIFIES
PAR USAGE ET PAR FORME D'ENERGIE
1989

Unité : Ktep

Energies / Usages	Produits pétroliers				gaz naturel	Eléctricité	Total (2)	Bois + charbon de bois	Total (1)+(2)	Proportion
	G.P.L	Pétrole	F.O.D	Total (1)						
Cuisson	202.0	9.4		211.4	11.7	0.0	223.1	11.7	234.8	48.6
Chauffage	4.2	41.3	14.6	60.1	5.2	1.2	66.5	31.9	98.4	20.3
Chauffe-eau	44.4	16.6		61.0	4.9	7.5	73.4	1.9	75.3	15.6
Réfrigérateur						32.3	32.3		32.3	6.7
Eclairage						22.6	22.6		22.6	4.7
Téleviseur						16.5	16.5		16.5	3.4
Autres						3.5	3.5		3.5	0.7
Total	250.6	67.3	14.6	332.5	21.8	83.6	437.9	45.5	483.4	100.0
Proportion %	51.8	14.0	3.0	69.0	4.5	17.3	90.6	9.4	100.0	

(1) Total des produits pétroliers
(2) Total des énergies commerciales
(3) Total toutes énergies confondues.

Source: STEG, AME 1991

HOUSEHOLD ENERGY EQUIPMENT IN 1989

Equipment	Tunis	North-East	North West	Centre East	Center West	South	Total	Urban	Rural
Refrigerator	68.5	41.7	28.9	17.3	52.7	52.1	46.1	67.4	13
Televisor	84.7	71.1	56.7	39.5	74.7	68.7	68	84.7	42.1
Radio	77.7	69.8	63.5	42.5	75.2	67.9	67.6	78.6	50.4
Cooker	89.8	80.3	75.4	67.5	86.4	90.3	82.5	92	67.8

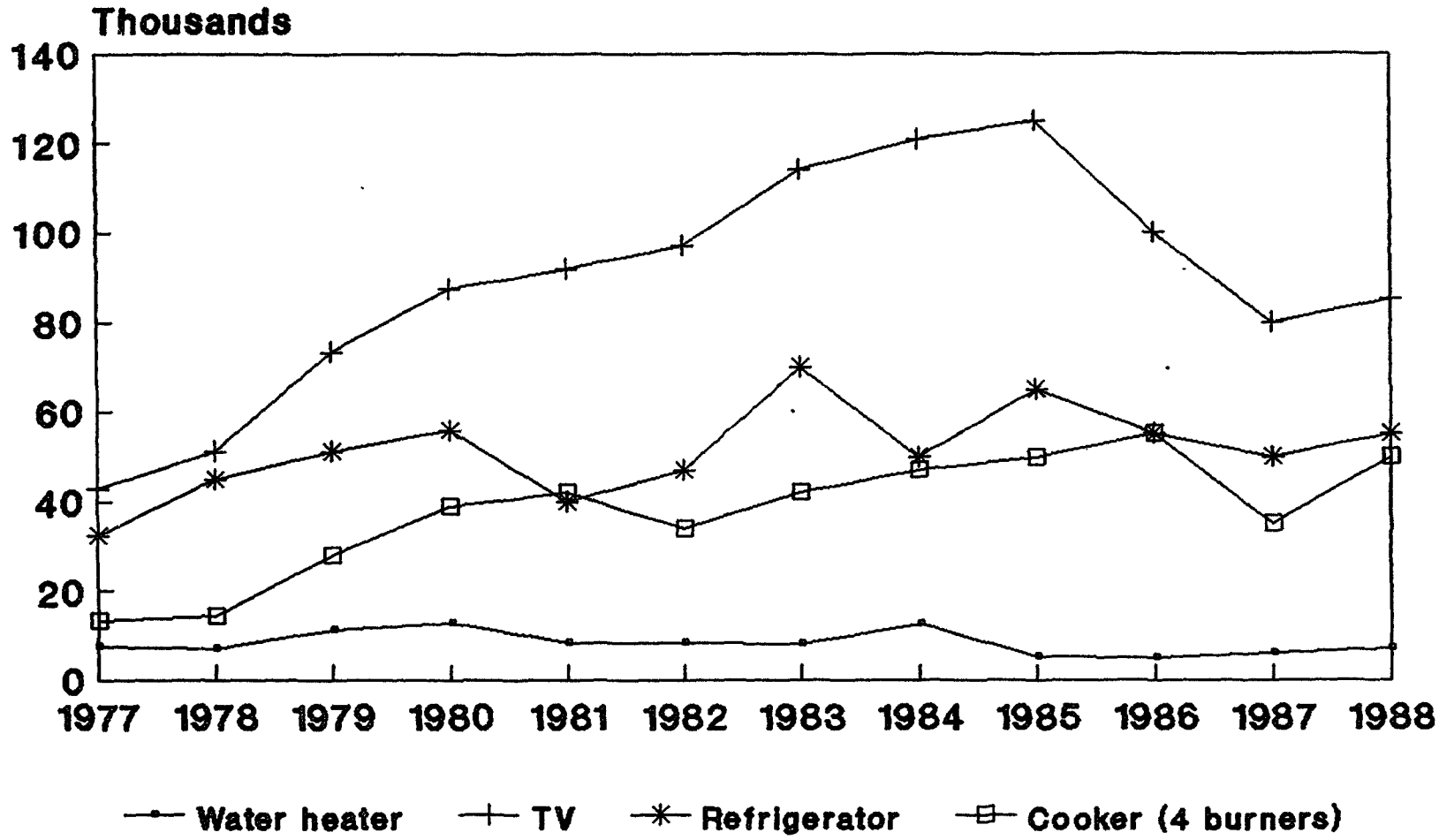
In % of total households
Source: INS, 1991

SALES SUMMARY OF THE MANUFACTURERS OF HOUSEHOLD APPLIANCES
(in thousands)

	1985				1986				1987			
Appliance	Total	%	Including elec	%	Nb.	%	Including elec	%	Nb.	%	Including elec	%
Water-heater	30	9%	4	2%	20	8%	4	3%	21	7%	5	3%
Televisions	104	33%	104	57%	71	27%	71	49%	55	19%	55	38%
Refrigerators	55	17%	55	30%	54	21%	54	37%	56	20%	56	38%
Cookers	79	25%			76	29%			94	33%		
Including, plates	27				45				59			
Heating systems	33	10%	1	1	25	10%	0	0%	33	12%	6	4%
A/C systems	3	1%	3	1%	1	1%	1	1%	3	1%	3	2%
Washing machines	14	5%	14	8%	14	5%	14	10%	22	8%	22	15%
Including, imported	7		7		3		3		10		10	
Total	317	100%	181	100%	261	100%	144	100%	283	100%	146	100%
Including, elec.			57%				55%				52%	

Source: AME manufacturer survey and customs' statistics, 1989.

PRODUCTION OF HOUSEHOLD APPLIANCES
Total Tunisia



Source: General Directorate of Planning

FINAL ENERGY CONSUMPTION OF HOTELS (1987)

	Unit	4 Stars		3 Stars		2 Stars		Others a/		TOTAL	
Number		37	9%	83	19%	87	20%	228	52%	435	100%
Number of beds		15,009	15%	34,752	34%	23,946	24%	27,961	28%	101,668	100%
Beds occupied b/	x 1,000/year	2,657		6,153		4,240		4,950		18,000	
ENERGY SOURCE c/:											
Electricity	%/effectif	100%		100%		100%		100% (*)			
LPG	%/effectif	11%		16%		53%		53% (*)			
Natural gas	%/effectif	89%		84%		47%		47% (*)			
Fuel oil, diesel	%/effectif	68%		70% (*)		74%		74% (*)			
CONSUMPTION PER UNIT:											
Number of audits		5		4		1				10	
Electricity	kWh/bed	27.0		9.5		3.8		1.5 (*)			
LPG	kg/bed	0.7		0.2		0.2		0.2 (*)			
Natural gas	m3/bed	3.0		1.2		1.0		0.8 (*)			
Fuel Oil, diesel	l/bed	5.9		2.9		2.5 (*)		2.1 (*)			
GLOBAL CONSUMPTION:											
Electricity	MWh/year	71,652	47%	58,303	38%	16,265	11%	7,426	5%	153,645	100%
LPG	ton/year	199	14%	198	14%	493	34%	575	39%	1,465	100%
Natural gas	x1,000m3/year	7,079	41%	6,219	36%	2,008	12%	1,876	11%	17,183	100%
Fuel Oil, diesel	m3/year	10,667	28%	12,465	32%	7,810	20%	7,660	20%	38,601	100%
Electricity	TOE/year	6,162	28%	5,014	23%	1,399	13%	639	7%	13,213	21%
LPG	TOE/year	220	1%	219	1%	545	5%	636	7%	1,620	3%
Natural gas	TOE/year	6,371	29%	5,597	26%	1,807	17%	1,688	18%	15,464	24%
Fuel Oil, diesel	TOE/year	9,177	42%	10,725	50%	6,719	64%	6,591	69%	33,212	52%
TOTAL (tep/an)		21,931	100%	21,555	100%	10,470	100%	9,554	100%	63,510	100%

(*) Mission estimates.

a/ One star, no classified, family boards and holiday resorts.
b/ 1987 estimate based on a constant occupation ratio of 50%.
c/ According to AME marked survey for 400 hotels (79 annexes).

FINAL ENERGY CONSUMPTION OF RESTAURANTS (1987)

	Unit	Touristic Restaurant	Non-touristic Restaurant	Small Restaurant	Cafes/bars c/	TOTAL	
Number 1987 b/		102	800	1,200	2,000	4,102	
ENERGY SOURCE c/:							
LPG		33%	79%	86%	86%		
Natural Gas		67%	19%	13%	13%		
Electricity		100%	100%	100%	100%		
CONSUMPTION PER UNIT:							
LPG	kg/year	2,067	2,199	1,548	1,548		
Natural Gas	KOE/year	6,600	2,500	1,200	1,200		
Electricity	kWh/year	15,134	6,827	3,897	3,897		
GLOBAL CONSUMPTION:							
LPG	TOE/year	77	1,529	1,761	2,935	6,302	68%
Natural gas	TOE/year	449	381	184	307	1,321	14%
Electricity	TOE/year	133	470	402	670	1,675	18%
TOTAL		659	2,380	2,347	3,912	9,298	100%

a/ Estimated from ONTT data.
b/ Excluding charcoal for food-grilling.
c/ Consumption assimilated to the consumption of small restaurants.

Source: Survey "Turkish baths/restaurants" (May-June 1989).

FINAL ENERGY CONSUMPTION OF TURKISH BATHS (1987)

	Districts, Rural towns >10,000 inh.	Districts, Rural towns >2,000 inh.	Rural towns <2,000 inh.	TOTAL	
Number 1984 a/	94.00	137.00	1,100.00		
Population 1987	3,714,399.00	625,748.00	1,371,616.00		
Average population	39,515.00	4,568.00	1,247.00		
Turkish bath/1000 inh.	0.20	0.40	0.10		
Number	646.00	262.00	137.00	1,045.00	
ENERGY SOURCE:					
Diesel	58%	53%			
Diesel + wood	12%				
Diesel + kerosene	6%				
Kerosene	22%	6%			
Kerosene + wood	6%				
Wood	11%	19%	100%		
Natural gas	1%				
Electricity	100%	80%	50%		
GLOBAL CONSUMPTION (TOE/year):					
Diesel	17,997.00	6,848.00		24,845.00	49.4%
Kerosene	6,739.00	895.00		7,634.00	15.2%
Natural gas	227.00			227.00	0.5%
Wood	4,260.00	4,865.00	8,230.00	17,355.00	34.5%
Electricity	167.00	54.00	18.00	238.00	0.5%
TOTAL	29,390.00	12,662.00	8,248.00	50,299.00	100.0%

Consumption per unit: (in TOE/Turkish bath/year)

Diesel:		Wood:	
Diesel only	46	Wood only	60
Diesel + wood	15	Wood + Diesel	40
Diesel + kerosene	20	Wood + kerosene	40
Kerosene:			
Kerosene only	42	Natural gas	35
Kerosene + wood	15	Electricity	3,000
Kerosene + diesel	20	(kWh/year)	

a/ According to 1984 INS Census.

Source: Survey "Turkish baths-restaurants" (May-June 1989).

COMPLEMENTARY RESULTS OF THE TURKISH BATHS SURVEY
(Population 1984)

TOWN REF.	CAT	Popu	Number baths m	Baths/ 2,000 pers	Kerosene	Diesel	Wood	Ker+Wood	Diesel+Wood	Not Known
1	1	1646	0	0.00			1			
2	1	1594	1	1.25		1				
3	3	4316	1	0.46			1			
4	2	2645	1	0.76						
5	1	1280	0	0.00						
6	1	1275	0	0.00						
7	2	3985	3	1.51		3				
8	1	897	0	0.00						
9	2	3723	1	0.54		1				
10	3	6189	2	0.65		2				
11	2	2976	4	2.69	1	1				2
12	2	2222	0	0.00						
13	1	1915	0	0.00						
14	1	1806	0	0.00						
15	2	3025	1	0.66		1				
16	3	5274	3	1.14			1	1	1	
17	2	3056	2	1.31						2
18	3	7462	1	0.27					1	
19	2	2970	1	0.67			1			
TOTAL		58256	21		1	9	4	1	2	4
					6%	53%	24%	6%	12%	
# ANSWERS	CAT	7	7	7	0	0	1	0	0	0
TOTAL	1		1	1			1			
AVERAGE		1488	0.1	0.2			1.0			
# ANSWERS	CAT	8	8	8	1	4	2	0	0	2
TOTAL	2		13	8	1	6	2			4
AVERAGE		3075	1.6	1.0	1.0	1.5	1.0			2.0
# ANSWERS	CAT	4	4	4	0	2	1	1	2	0
TOTAL	3		7	3		3	1	1	2	
AVERAGE		5810	1.8	0.6		1.5	1.0	1.0	1.0	

CAT 1 = Rural towns with under 2,000 inhabitants.
CAT 2 = Rural towns with 2 to 4,000 inhabitants.
CAT 3 = Rural towns with more than 4,000 inhabitants.

LPG AND KEROSENE PRICES
(in DT/TOE)

	LPG				Kerosene			
	1984	1985	1986	1987	1984	1985	1986	1987
CIF Price	189	190	92	139	203	225	115	142
STIR sale price	64	72	72	72	72	78	111	122
Transport, margin, costs	92	101	101	101	22	27	28	29
Taxes	33	34	34	34	27	29	31	31
Retail price (A)	189	208	208	208	121	134	170	182
CIF price + costs + transport + margins (B)	281	291	193	240	225	252	144	171
A-B	(92)	(83)	15	(32)	(104)	(118)	26	11

Sources: 1988 data from ETAP. Price structure at July 1, 1988, and maritime base.

FORECAST POPULATION (1987-2000)
(in number of households)

Region	Area	Annual growth 1975-1984 Popu	Annual growth 1975-1984 Hous.	Share 87	Share 95	Share 2000	Men 87	Men 95	Men 200
Tunis	Total	3.2%	3.6%	22%	23%	24%	296	392	467
North East	Total	2.1%	2.3%	14%	14%	13%	191	230	258
North West	Total	1.4%	2.0%	15%	15%	14%	212	248	273
Center East	Total	2.4%	2.5%	21%	21%	21%	290	354	401
Center West	Total	2.7%	2.3%	14%	13%	13%	188	225	252
South	Total	3.1%	2.7%	14%	15%	15%	199	246	281
Tunisia	Total	2.5%	2.6%	1,376	1,695	1,927			
(x 1,000 household)	Urban	3.2%	3.7%	782	1,052	1,262			
	Rural	1.8%	1.5%	594	643	666			
	Inc., dispersed	-1.2%	-1.2%	291	277	261			
Tunisia	Urban			57%	62%	65%			
(in %)	Rural			43%	38%	35%			
	Inc., dispersed			21%	16%	14%			

Source: 1975 and 1984 INS census and mission estimates.

HOUSEHOLD DISTRIBUTION PER LEVEL OF EXPENDITURE

Level of Expenditure (DT/pers/yr)	Average annual Variation 75-85			Average annual Variation 80-85		
	URB	RUR	TOT	URB	RUR	TOT
<100	-18.4%	-8.3%	-9.9%	-13.7%	-11.8%	-12.0%
100-350	-0.5%	2.2%	1.0%	-0.2%	1.9%	1.1%
150-500	2.5%	3.4%	2.9%	1.8%	3.6%	2.7%
>500	9.7%	6.0%	8.9%	7.3%	8.7%	7.6%
>800	10.6%	6.8%	10.0%	9.4%	13.4%	9.9%

Source: National Surveys "Household Budget and Expenditure" INS, 1975, 1980 and 1985.

POPULATION DISTRIBUTION ACCORDING TO EXPENDITURE AND AREA (%)
(constant prices of 1985)

	Urban			Rural		
	1975	1980	1985	1975	1980	1985
<100	6.6	1.5	0.6	22.0	16.1	8.0
100-150	9.4	4.6	3.2	17.7	18.2	16.2
150-250	26	17.5	13.2	29.7	30.9	31.7
250-350	17.1	20.1	18.5	14.2	15.5	18.5
350-500	17.2	21.1	22.1	8.7	10.9	13.7
500-800	13.5	20.4	22.5	5.6	6.4	8.4
>=800	10.2	14.8	19.4	2.1	2.0	3.5
	100.0	100.0	99.5	100.0	100.0	100.0

Urban = Districts and rural towns with more than 2,00.

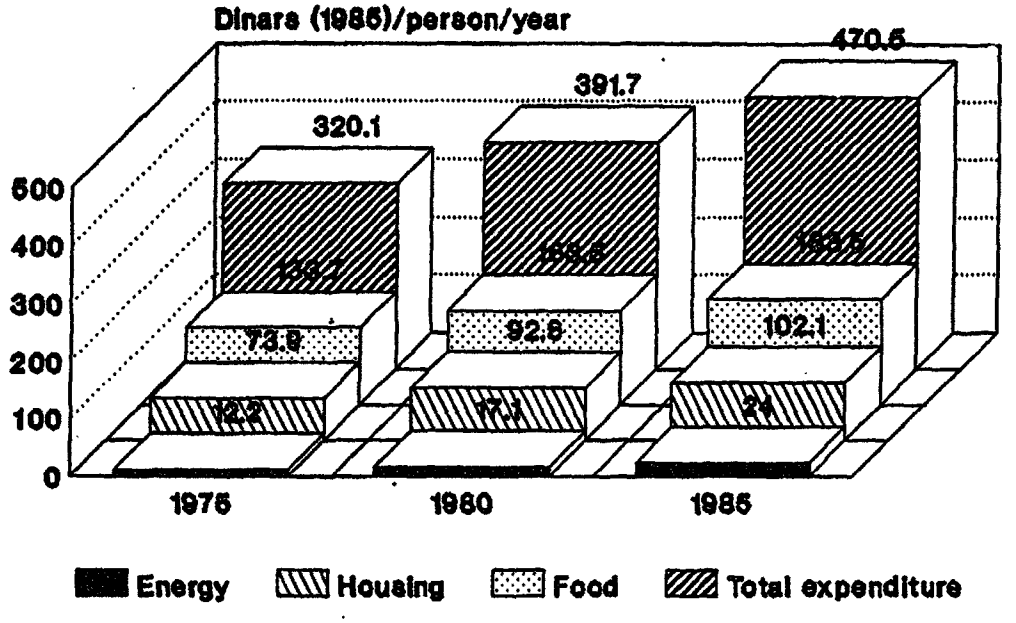
STRUCTURE OF HOUSEHOLD EXPENDITURE
(DT/person/year)
(Constant prices of 1985)

	1975		1980		1985	
Total expenditure	320	100%	392	100	471	100%
Growth/per year			4.1%		3.7%	
Including:						
Food	134	42%	164	42%	184	39%
Growth/year			4.1%		2.3%	
Housing	74	23%	93	24%	102	22%
Growth/year			4.6%		2.0%	
Energy	12	4%	17	4%	24	5%
Growth/year			7.0%		7.0%	
Appliances	3	1%	4	1%	5	1%
Growth/year			3.4%		2.9%	

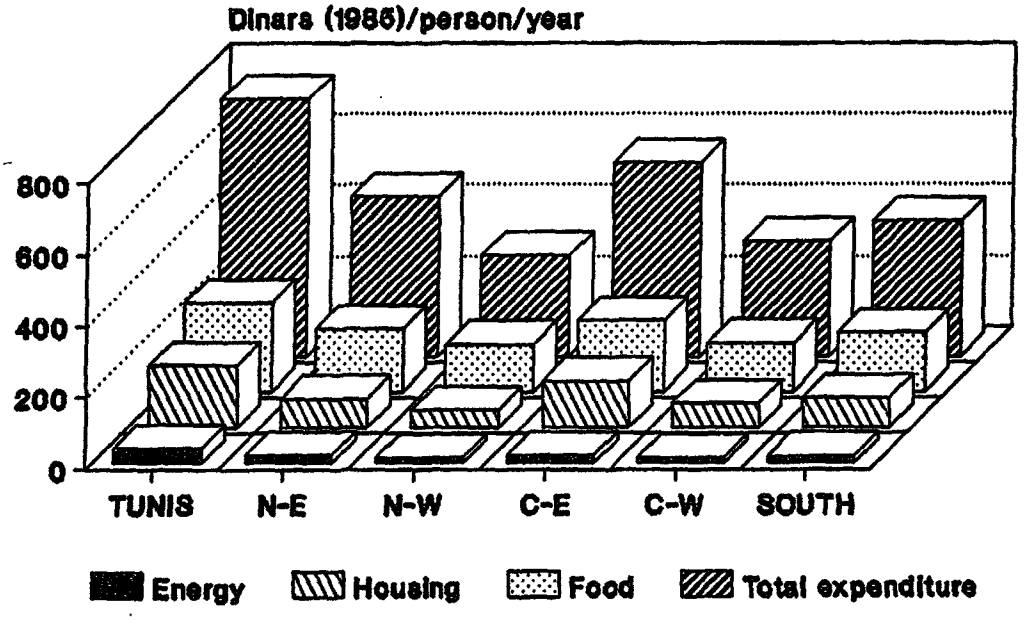
Source: INS National Surveys, "Budget and expenditure".

HOUSEHOLD EXPENDITURE

Total Tunisia



By region in 1985



Source: Household Expenditure Survey INS

POPULATION DISTRIBUTION PER EXPENDITURE CATEGORY

Area	Categ	Household Distribution (%) 1984	1987	1995	2000	Number of households (thousands) 1984	1987	1995	2000
Rural	1	40%	37%	26%	22%	229	217	167	146
	2	40%	43%	48%	50%	229	252	309	333
	3	17%	18%	23%	25%	97	107	148	166
	4 & 5	3%	3%	3%	3%	17	18	19	20
					S/total	572	594	643	666
Urban	1	8%	7%	5%	3%	54	55	53	38
	2	26%	26%	25%	25%	181	203	263	315
	3	32%	31%	26%	23%	221	242	274	290
	4	23%	23%	26%	29%	164	180	274	366
	5	12%	13%	18%	20%	81	102	189	252
					S/total	701	782	1,052	1,262
					TOTAL	1,273	1,376	1,695	1,927

Note: Household distribution per category was estimated from Annex 11 for the following categories:

Category	Level of Expenditure (DT/person/year)
1	< 100
2	100 à 350
3	150 à 500
4	> 500
5	> 800

Source: Amous and Ouerghi (1986), INS survey "Household Budget. Expenditure" (1985) and mission estimates.

CONSUMPTION TRENDS OF OTHER PETROLEUM PRODUCTS
(Urban Areas)

Product	Categ	Cons/hous (TOE/year)	Households Using 1984	1987	1995	2000	Consumption (x1,000 TOE/year) 1984	1987	1995	2000
Diesel	4	1.00	2%	3%	4%	5%	3	5	11	18
	5	1.33	14%	15%	18%	20%	15	21	46	67
						S/total	18	25	57	86
Fuel Oil	5	1.03	4%	4%	5%	6%	3	5	10	16
				TOTAL DIESEL+FUEL OIL			22	30	67	10[illegible]
					x1,000 TOE/year		21	29	66	99
					Growth/year			10.8%	10.8%	8.5%
Natural gas	3	0.34	2%	3%	4%	5%	2	2	4	5
	4	0.40	5%	6%	8%	10%	3	4	9	15
	5	0.44	14%	15%	18%	20%	5	7	15	22
						TOTAL	10	13	28	42
					x1,000 m3/yr		10,865	14,630	31,203	46,334
					Growth/year			10.4%	9.9%	8.2%

LPG CONSUMPTION TRENDS

Area	Categ	Households using	Cons/hous. TOE/yr	Consumption (x1,000 TOE/year) 1984	1987	1995	2000
Rural	1	38%	0.12	11	10	8	7
	2	70%	0.13	21	23	28	30
	3	89%	0.14	12	13	18	21
	4 & 5	95%	0.20	3	3	4	4
			S/total	47	50	58	62
Urban	1	63%	0.11	4	4	4	3
	2	83%	0.14	21	23	30	36
	3	93%	0.16	33	36	40	43
	4	89%	0.20	29	31	48	64
	5	86%	0.24	17	21	39	51
			S/total	102	115	161	197
			TOTAL	149	165	219	259
			x1,000 TOE/yr	135	149	198	234
			Growth/yr.		3.4%	3.6%	3.4%

KEROSENE CONSUMPTION TRENDS

Area	Categ	Households using	Cons/hous. TOE/yr	Consumption (x1,000 TOE/year) 1984	1987	1995	2000
Rural	1	89%	0.16	33	32	24	21
	2	84%	0.17	32	35	43	46
	3	64%	0.18	11	12	17	19
	4 & 5	40%	0.20	1	1	2	2
			S/total	77	80	85	88
Urban	1	83%	0.16	7	7	7	5
	2	63%	0.18	20	23	29	35
	3	50%	0.14	16	17	19	20
	4	41%	0.13	9	10	15	20
	5	35%	0.25	7	9	17	22
			S/total	59	66	87	103
			TOTAL	136	146	172	190
			x1,000 TOE/ yr	132	141	167	184
			Growth/yr		2.3%	2.1%	2.0%

WOOD CONSUMPTION TRENDS

Area	Categ	Households using	Cons/hous TOE/yr	Consumption (x1,000 TOE/year) 1984	1987	1995	2000
Rural	1	81%	1.06	196	186	144	126
	2	81%	0.76	140	155	189	204
	3	68%	0.63	42	46	64	72
	4 & 5	30%	0.30	2	2	2	2
			S/total	380	388	398	403
Urban	1	35%	0.28	11	11	11	8
	2	23%	0.36	15	17	22	26
	3	7%	0.35	5	6	7	7
			S/total	31	34	39	41
			TOTAL	411	422	437	444
			x1,000 tons/yr	1,097	1,126	1,166	1,184
			Growth/yr		0.9%	0.4%	0.3%

CHARCOAL CONSUMPTION TRENDS

Area	Categ	Households using	Cons/hous TOE/yr	Consumption (x1,000 TOE/year) 1984	1987	1995	2000
Rural	1	40%	0.15	14	13	10	9
	2	62%	0.14	20	22	27	29
	3	78%	0.17	13	14	19	22
	4 & 5	30%	0.10	1	1	1	1
			S/total	47	50	57	60
Urban	1	77%	0.12	5	5	5	3
	2	76%	0.14	19	22	28	34
	3	72%	0.14	22	24	27	28
	4	35%	0.09	5	6	9	12
	5	24%	0.09	2	2	4	6
			S/total	53	58	73	83
			TOTAL	100	108	129	143
			x1,000 tons/yr	143	154	185	204
			Growth/yr		2.6%	2.3%	2.0%

ELECTRICITY CONSUMPTION TRENDS

Area	Categ	Cons/hous TOE/yr	Households using 1984	1987	1995	2000	Consumption (x1,000 TOE/year) 1984	1987	1995	2000
Rural	1	0.03	16%	18%	25%	29%	1	1	1	1
	2	0.03	29%	34%	49%	58%	2	2	4	5
	3	0.05	56%	61%	76%	76%	3	3	5	6
	4 & 5	0.14	56%	61%	76%	76%	1	2	2	2
						S/total	6	8	12	14
Urban	1	0.02	58%	65%	84%	96%	1	1	1	1
	2	0.04	83%	86%	95%	100%	6	7	10	12
	3	0.06	96%	97%	100%	100%	12	14	16	17
	4	0.10	99%	99%	100%	100%	17	18	28	37
	5	0.17	100%	100%	100%	100%	14	18	33	44
						S/total	50	57	87	111
						TOTAL	56	65	100	125
						in GWh/yr.	653	757	1,158	1,456
						Growth/yr.		5.0%	5.5%	4.7%

Note: Household distribution per category is given in Annex 12.

Source: Amous and Ouerghi (1986), STEG electrification targets and mission estimates.

SALES OF LPG, KEROSENE AND ELECTRICITY

	LPG			KEROSENE			ELECTRICITY LT					
Year	Sales (TOE)	Growth (TOE)		Sales (TOE)	Growth (TOE)		Sales (GWh)	Number Connections	Growth per connec.		Cons. (kWh/conn.)	Growth
1975				86,636								
1976	61,623			110,940	24,304	28.1%	387	441,391			876	
1977	66,794	5,171	8.4%	104,438	(6,502)	-5.9%	449	494,526	53,135	12.0%	908	3.7%
1978	79,180	12,386	18.5%	113,881	9,443	9.0%	515	549,836	55,310	11.2%	936	3.1%
1979	91,409	12,229	15.4%	112,333	(1,548)	-1.4%	577	612,464	62,628	11.4%	942	0.7%
1980	106,027	26,847	33.9%	118,938	6,605	5.9%	645	679,110	66,646	10.9%	950	0.8%
1981	122,168	16,141	15.2%	126,745	7,807	6.6%	731	753,923	74,813	11.0%	970	2.1%
1982	129,475	7,307	6.0%	122,287	(4,458)	-3.5%	790	816,427	62,504	8.3%	967	-0.3%
1983	143,244	13,769	10.6%	113,306	(8,981)	-7.3%	874	889,534	73,107	9.0%	982	1.6%
1984	171,430	28,186	19.7%	148,228	34,922	30.8%	965	938,069	48,535	5.5%	1,029	4.7%
1985	184,209	12,779	7.5%	158,891	10,663	7.2%	1,052	1,006,678	68,609	7.3%	1,045	1.6%
1986	195,762	11,553	6.3%	136,998	(21,893)	-13.8%	1,097	1,079,512	72,834	7.2%	1,016	-2.8%
1987	210,140	14,378	7.3%	158,673	21,675	15.8%	1,177	1,138,800	59,288	5.5%	1,034	1.7%
1988	223,412	13,272	6.3%				1,240	1,200,300	61,500	5.4%	1,033	0.0%
Growth 1977-84			14.4%			5.1%				9.6%		1.8%
Growth 1984-87			7.0%			2.3%				6.7%		0.2%
Growth 1977-87			12.1%			4.3%				8.7%		1.3%

Source: Petroleum products distributors and STEG.

LIST OF EQUIPMENT SUGGESTED FOR CUSTOM DUTY REDUCTION

Equipment to benefit from limited custom duty status

- Measuring equipment: probes, thermometers (in particular recording-thermometers), water flowmeters, wattmeters
- Integrated measuring sets
- Regulating and programming equipment
- Power factor reducers
- Centralized control systems
- Insulating materials

Technologies to be favoured through differential measures in relation with less ecomomic competing technologies

- Heating/Cooling equipment that can be transformed into heat pump systems
- Fluorescent lighting
- High efficiency components of solar water heaters (e.g. selective coatings)
- Efficient valves and mixing equipment

Some equipment and materials should not benefit from preferential custom duty status, such as:

- Basic thermal equipment: boilers, heating/cooling equipment, etc.
- Most building materials, even double-glazing

FORECAST MARKET OF MAIN COOKING FUELS
(trend in thousands of households)

		Total Users a/				New Users a/			
						1987-1995		1995-2000	
		1984	1987	1995	2000	Total	Ave/yr	Total	Ave/yr
Wood b/	Rural	442	458	492	507	34	3	16	1
	Urban	76	83	98	106	15	1	8	1
	Total	518	541	590	613	49	4	24	2
Including,	cooking	186	195	212	221	18	2	8	1
LPG	Rural	350	371	430	456	58	5	26	2
	Urban	605	676	912	1,098	236	21	186	17
	Total	955	1,047	1,342	1,554	294	27	212	19
Including,	cooking	927	1,016	1,301	1,507	285	26	206	19
Kerosene	Rural	465	481	510	524	30	3	14	1
	Urban	365	404	525	613	120	11	89	8
	Total	830	885	1,035	1,138	150	14	103	9
Including,	cooking	267	276	290	298	14	1	8	1
Natural Gas	Total	24	32	69	102	37	3	33	3

a/ y including end-users other than cooking.
b/ y including other biomass use and bread-making.

Table 1 : OVERVIEW OF CHARCOAL PRODUCTION PARAMETERS

Parameter	Mound no.1 (1)	Mound no.2 (2)
Wood weight wet (tonnes)	7.3	5.5
Moisture content wood (% wb)	23.1	34.7
Charcoal yield wet (tonnes)	1.71	0.80
Moisture content charcoal (% wb)	7.7	6.6
Charcoal composition		
Fixed carbon (%)	65.5	74.1
Moisture content (%)	7.7	6.6
Volatile content (%)	25.8	14.2
Ash content (%)	1.0	5.1
Team size (persons)	1	2
Wood cutting (persondays)	15	-
Wood preparation (persondays)	1	8
Levelling (persondays)	1	1
Mound construction (persondays)	2	4
Carbonisation duration (days)	9 - 10	9 - 10
Charcoal harvesting (persondays)	2	2
Total persondays	21 (3)	15 (4)
Carbonisation efficiency (%) (wet wood and charcoal weight basis)	23.4	14.5
Carbonisation efficiency (%) (dry wood and charcoal weight basis)	28.1	20.8
Charcoal production (kg/personday)	81	53

(1) using rootwood (from maquis bushes) near Nefza in the North West region
(2) using chain-saw prepared oak wood ("chêne-liège")
(3) price per kg of charcoal produced paid by merchant to charcoal producers: 0,090 DT/kg
(4) price per kg of charcoal produced paid by merchant to charcoal producers: 0.060 DT/kg

Source: mission findings

Table 2 : CHARCOAL PRODUCTION LABOUR COST

Cost	Case 1 (1) DT/kg charcoal (off roadside)	Case 2 (2) DT/kg charcoal (off roadside)
Manual cutting/preparation /carbonisation	0.090	
Mechanical cutting		0.020
Preparation/carbonisation		0.060
Transport to roadside	0.010	0.010
Checking/control/sacking/ loading	0.002	0.002
Total labour costs	0.102	0.092

(1) wood preparation with hand equipment
(2) wood preparation with mechanical equipment (chain saws)

Source: mission findings (North East region)

Table 14: Results from Water Boiling Tests with Gas Stoves

Stove Name	Burner	Power Max (kW)	Power Min (kW)	Turn-Down Ratio (-)	Pan Size (mm)	Eff (%)
Sotacer	Large	3,5	1,3	2,8	240	49
					220	49
	Middle	2,0	0,6	3,2	220	55
					200	53
	Small	1,1	0,6	1,9	180	46
Atlas	Large	3,7	0,7	5,0	240	50
					220	46
	Middle	1,5	0,5	3,1	200	54
					180	50
	Small	0,9	0,3	3,8	180	54
Confort Luxe	Large	2,0	n.a.	n.a.	240	55
					220	54
	Middle	1,5	n.a.	n.a.	200	52
	Small	0,8	n.a.	n.a.	180	51
Confort Economy	Large	2,0	0.4	5,4	220	54
	Middle	1,0	0,4	2,4	200	54
					180	54
	Small	0,7	0,3	2,0	180	53
Sotacer HP 3	Large	2,1	1,0	2,1	180	52
	Middle	1,7	0,8	2,2	180	58
	Small	1,0	0,4	2,4	180	57
Sotacer HP 1		3,2	0,6	5,3	240	46

Table 15: Water Boiling Test Results with Kerosene, Charcoal and Woodstoves

Name	Power Max (kW)	Min (kW)	Turn-Down Ratio (-)	Pan Size (mm)	Eff (%)
Kerosene					
Sotulus Economy	1,1	0,4	2,7	220	46
				200	42
Sotulus Luxe	1,9	0,9	2,2	220	43
				200	45
Superior	2,9	0,7	4,5	240	54
				220	49
				200	46
Charcoal					
Clay Canoun Maxi	6,7	2,3	2,9	240	10
Clay Canoun Midi	4,1	1,4	2,9	200	9
Clay Canoun Mini	3,8	1,1	2,6	180	10
Metal Canoun Maxi	4,5	0,8	6,2	220	11
Metal Canoun Midi	2,1	0,3	6,7	180	14
Ghana Model	2,4	0,4	6,3	220	18
				200	17
				180	14
Woody Fuels					
Multi-Pan Stove	2,6	0,5	6,8	240	30
				220	28
				200	23
Open Fire	2,7	1,2	2,5	240	18
				220	21
				200	18

Table 16: Results from Controlled Cooking Test

Name	Burner	Sauce (kg)	Couscous (kg)	Fuel (kg)	SEC (MJ/kg)
Gas					
Sotacer	Middle	3.2	1,7	0,17	1,6
Atlas	"	3,2	1,7	0,18	1,8
Confort Luxe	"	2,9	1,6	0,17	1,7
Confort Economy	"	3,0	1,4	0,15	1,6
Sotacer HP 3	"	3,4	1,6	0,12	1,1
Sotacer HP 1	"	3,2	1,6	0,12	1,2
Kerosene					
Sotulus Economy		3.9	1,7	0,14	1,1
Sotulus Luxe		3,9	1,6	0,14	1,1
Superior		2,8	1,7	0,15	1,4
Charcoal					
Clay Canoun Maxi		3,7	1,7	0,73	3,9
Metal Canoun Maxi		3,2	1,6	0,59	3,6
Ghana Model		3,3	1,7	0,56	3,6
Woody Fuels					
Open Fire		3,4	1,7	1,36	3,9
Multi-Pan Stove		3,2	1,8	1,12	3,2

Table 17: Summary of Test Results

Fuel			Stove		
Name	Unit	Price (Dinar/TOE)	Name	Price (Dinar)	Energy Savings (%)
Gas	kg	223			
			Table Cookers	> 170	55 %
			Hot Plates		
			Sotacer HP-3	60	70 %
			Sotacer HP-1	40	70 %
Kerosene	litre	194			
			Primus Type	15	70 %
			Superior	15	65 %
Charcoal	kg	429			
			Clay Canoun	0,600	0 %
			Metal Canoun	1,200	10 %
			Ghana Model	2,000	10 %
Woody Fuels	kg	16			
			Open Fire	0,000	0 %
			Multi Pan Stove	1,800	20 %

TECHNOLOGIE AMELIOREE DE LA CONSOMMATION DU BOIS

Acceptabilité Socio-Technico-Economique

Cuisinière / Appréciation	FILIERE TAJINE			FILIERE TABOUNA			
	Tajine Traditionnel en terre cuite	Tajine Algérien Diamètre : 30 cm	Tajine Aluminium Diamètre : 30 cm	Tabouna Traditionnelle	TAM II	TAC	TAGAZ
Combustible	Bois	GPL	GPL	Bois et excréments d'animaux	Bois	Romarin et excréments d'animaux	Gaz
Type de pain	Pain Tajine	Pain Tajine	Pain Tajine	Pain Tabouna	Pain Tabouna	Pain Tabouna	Pain Tabouna
Rendement (%)	5.8	17.3	26.6	N.D.	3.8	2.4	1.5
Consommation spécifique (MJ/Kg pât) Moyenne d'énergie	6.66	2.15	1.3	22	6	8	20.5
Avantages	- Qualité du pain - tradition	Peut substituer le bois	- Fabriqué localement	Tradition	Réduction de la consommation du bois	Réduction de la consommation du bois	
Inconvénients	Consommation du bois	- Diamètre - Distribution irrégulière	- Fragile	Consommation du bois	Coût		
Remarques	Sur 3 pierres	Risque d'être utilisé avec du bois	Utilisation à feu doux			Coût à diminuer	Tentatives d'amélioration non concluantes
Acceptabilité	Tradition	Non accepté	Non encore vulgarisé	Tradition	Acceptabilité partielle à cause de problèmes techniques provisoires	Acceptée	Non vulgarisée
Coût	1.000 DT	3.5 DT	2 à 3 DT	Nul	Non encore estimé	Non encore estimé	
Commentaire	Tajine Aluminium à vulgariser.			- TAGAZ techniquement non encore au point - Les tests sur la Tabouna traditionnelle non encore réalisés par l'équipe - Une série de tests est à prévoir pour assurer des améliorations et sélectionner le produit final proposé pour vulgarisation élargie.			

TECHNOLOGIE AMELIOREE DE LA CONSOMMATION DU BOIS

Acceptabilité Socio-Technico-Economique

	FILIERE CANOUN (Pain Tajine)			FILIERE CUISINIERE	FILIERE FOUR
Cuisinière / Appréciation	Canoun Traditionnel	Canoun Sup.	Canoun Amélioré	Cuisinière Colombienne	Four Marocain
Combustible	Bois	Bois	Bois	Pétrole	GPL
Type de pain	Pain Tajine	Pain Tajine	Pain Tajine	Pain Tajine	Pain Tabouna
Rendement 1 (%)	3.2	5.9	7.4		22.4
Consommation spécifique	7.7	6.1	5.0		2.1
Avantages		Faible réduction de la consommation du bois	Possibilité de substitution du bois		- Substitution au bois - Autre utilisation - Possibilité d'une future production local - Simplicité
Inconvénients				Mon fonctionnement	- Mon existence sur le marché local actuellement - Qualité du pain différente du pain traditionnel
Remarques	Essais réalisés avec Tajine traditionnel	Essais réalisés avec Tajine traditionnel	Essais réalisés avec Tajine traditionnel	Produit rejeté	
Acceptabilité	Tradition	Mon vulgarisé	Mon vulgarisé	Mon vulgarisée	Mon encore vulgarisé
Coût	1.000 DT	Mon encore estimé	Mon encore estimé		Environ 70 DT (Prix au Maroc acheté par 2 étrangers
Commentaire	Pas de produit nouveau à proposer vu l'existance de produits locaux équivalents et la non existance d'améliorations sensibles.			Filière abandonnée pour non fonctionnement de manière sécurisante.	Filière très prometteuse à suivre en vue d'une action soutenue.

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME

COMPLETED ACTIVITIES

Country	*Activity*	*Date*	*Number*
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English - Out of Print)	05/89	--
	Francophone Household Energy Workshop (French)	08/89	103/89
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English - Out of Print)	03/90	112/90
	Biomass Assessment and Mapping (English - Out of Print)	03/90	--
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	--
	Urban Household Energy Strategy Study (English - Out of Print)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (Out of Print)	01/84	012/84
	Status Report (English and French)	02/84	011/84
	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Comoros	Energy Assessment (English and French)	01/88	7104-COM
Congo	Energy Assessment (English)	01/88	6420-COB
	Power Development Plan (English and French)	03/90	106/90
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (Out of Print)	12/87	--
	Power Sector Efficiency Study (French)	02/92	141/91
Ethiopia	Energy Assessment (English)	07/84	4741-ET
	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	--
Gabon	Energy Assessment (English)	07/88	6915-GA

Country	*Activity*	*Date*	*Number*
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85
Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
Guinea	Energy Assessment (Out of Print)	11/86	6137-GUI
Guinea-Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English and Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800-KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English - Out of Print)	02/87	--
	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English - Out of Print)	11/87	--
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
	Power System Efficiency Study (English and French)	12/87	075/87
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83
	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87
	Bagasse Power Potential (English)	10/87	077/87
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
Rwanda	Energy Assessment (English)	06/82	3779-RW
	Energy Assessment (English and French)	07/91	8017-RW
	Status Report (English and French)	05/84	017/84
	Improved Charcoal Cookstove Strategy (English and French)	08/86	059/86

Country	*Activity*	*Date*	*Number*
Rwanda	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	--
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84
	Industrial Energy Conservation Study (English)	05/85	037/85
	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
Sudan	Management Assistance to the Ministry of Energy and Mining (English)	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84
	Wood Energy/Forestry Feasibility (English - Out of Print)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	--
	Industrial Energy Efficiency Technical Assistance (English - Out of Print)	08/90	122/90
Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86
	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English - Out of Print)	03/86	053/86
	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English - Out of Print)	03/89	UNDP Terminal Report
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM

Country	*Activity*	*Date*	*Number*
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85
	Petroleum Management Assistance (English)	12/89	109/89
Zimbabwe	Power Sector Management Institution Building (English - Out of Print)	09/89	--
	Charcoal Utilization Prefeasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM

EAST ASIA AND PACIFIC (EAP)

Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	--
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Energy Strategy Paper (English - Out of Print)	--	--
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English - Out of Print)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English - Out of Print)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
Tonga	Energy Assessment (English)	06/85	5498-TON
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Western Samoa	Energy Assessment (English)	06/85	5497-WSO

Country	*Activity*	*Date*	*Number*
	SOUTH ASIA (SAS)		
Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Prefeasibility Study (English - Out of Print)	12/88	--
India	Opportunities for Commercialization of Nonconventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	05/91	120/91
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84
Pakistan	Household Energy Assessment (English - Out of Print)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86
	EUROPE AND CENTRAL ASIA (ECA)		
Portugal	Energy Assessment (English)	04/84	4824-PO
Turkey	Energy Assessment (English)	03/83	3877-TU
	MIDDLE EAST AND NORTH AFRICA (MNA)		
Morocco	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector(English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English - Out of Print)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91
	LATIN AMERICA AND THE CARIBBEAN (LAC)		
LAC Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--

Country	*Activity*	*Date*	*Number*
Bolivia	National Energy Plan (Spanish)	08/91	131/91
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Prefeasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	Private Power Generation and Transmission (English)	01/92	137/91
Chile	Energy Sector Review (English - Out of Print)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English - Out of Print)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English - Out of Print)	03/88	--
	Management Information System Phase I (English - Out of Print)	03/88	--
	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
Panama	Power System Efficiency Study (English - Out of Print)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English - Out of Print)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English - Out of Print)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (Spanish)	12/90	--
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Trinidad and Tobago	Energy Assessment (English - Out of Print)	12/85	5030-TR

Country	*Activity*	*Date*	*Number*
	GLOBAL		
	Energy End Use Efficiency: Research and Strategy (English - Out of Print)	11/89	--
	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
	Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--