Report No. 11703-BU

Burkina Faso
Electric Power Sector Development Review

February 28, 1994

Industry and Energy Operations Division
Sahelian Department
Africa Region

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Document of the World Bank

CURRENCY EQUIVALENTS

Currency Unit = CFA Franc (CFAF)

12/08/93	US$1	=	CFAF 293.6	2/27/94	US$1	=	CFAF 587.1
12/08/93	SDR 1	=	US$1.3881	2/27/94	SDR 1	=	US$1.391

ACRONYMS AND ABBREVIATIONS

CCCE	Caisse Centrale de Coopération Economique[1]
CPPEG	Cellule des Programmes et Prévisions Economiques Générales (General Economic Programming and Projections Unit)
DANIDA	Danish Development Agency
DPC	Danish Power Consult
ECG	Electricity Corporation of Ghana
ECOWAS	Economic Community of West African States
EdF	Electricité de France
ENERGIE AOF	Energie de l'Afrique Occidentale Française (French West Africa Power)
GMB	Grands Moulins du Burkina Faso (Burkina Mills)
IBE	Institut Burkinabé de l'Energie (Burkina Faso Energy Institute)
IBICA	Impôts sur les Bénéfices Industriels, Commerciaux et Agricoles (Industrial, Commercial and Agriculture Profits Taxes)
IMFPIC	Impôt Minimum Forfaitaire sur les Professions Industrielles et Commerciales (Minimum Flat-Rate Tax on Industrial and Commercial Professions)
MDEM	Delegated Minister of Energy and Mining
MESSRS	Ministry of Secondary and Higher Education and Scientific Research
MET	Ministry of Environment and Tourism
MICM	Ministry of Industry, Trade and Mining
SAFELEC	Société Africaine d'Electricité (African Electric Power Company)
SOFITEX	Société des Fibres Textiles (Textile Fibers Company)
SONABEL	Société Nationale d'Electricité du Burkina (Burkina Electric Power)
SONABHY	Société Nationale Burkinabe d'Hydrocarbures (Burkina Hydrocarbons)
SOREMIB	Société de Recherches et d'Exploitation Minière du Burkina (Burkina Mining Research and Operations Company)
SOSUCO	Société Sucrière de la Comoe (Comoe Sugar Company)
UNDP	United Nations Development Program
UPDEA	Union des Producteurs et Distributeurs Electriques Africains (Union of African Electricity Generating and Distributing Companies)
VOLTELEC	Société Voltaïque d'Electricité (Upper Volta Electric Power Company)
VRA	Volta River Authority
WAEC	West African Economic Community
WAMU	West African Monetary Union

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[1] Now the Caisse Française de Développement (CFD).

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ELECTRIC POWER SECTOR DEVELOPMENT REVIEW

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FOREWORD

1. The purposes of this report are (i) to assess the current situation and development potential of the electric power sector in Burkina Faso; (ii) to identify the sector's main problems, development strategy and institutional framework, and (iii) to establish a basis for discussion with the Burkina authorities on the possible role of the World Bank in assisting the sector's development.

2. Danish Power Consult (DPC), with financing by Denmark Development Cooperation (DANIDA), helped to prepare and produce this report. A mission comprising Messrs Max Pilegaard and Michel Patou (Consultants) and Nadjib Sefta (World Bank, AF5IE) visited Burkina Faso from June 1 to 27, 1992 in order to (i) ascertain the current situation of the sector, (ii) gather the necessary documentation, and (iii) visit the major generating units in service and the recently completed electrification projects.

3. A second mission to Burkina Faso took place in June 1993 during which SONABEL presented its comments on the draft report.

4. This report was prepared and revised by Messrs Pilegaard, Patou and Sefta in collaboration with Mrs. Francoise J. Fabian, Mrs. Alvire C. Paul and Mr M. Guirbo, Staff Assistants. The report reviewers were Messrs Wilton (AFTPS) and Ouahes (EMTIE).

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The report was completed on December 8, 1993. The data and analysis do not take into account the parity change of the CFA Franc which occured on January 12, 1994. The delay between December 8, 1993 and February 28, 1994 is due to the preparation of the translation of the report into English.

SUMMARY AND CONCLUSIONS

Characteristics of the sector

1. There has been little development of the electricity sector in Burkina Faso. Total electricity consumption, which was about 270 GWh in 1992, corresponds to a per capita average of only 28 kWh/year, one of the lowest in the world.[2] This average is, in any case, not very significant because only 4% of the population actually has access to electricity.

2. The sector is composed of a public electricity corporation, SONABEL, which is the sole distributor, and a certain number of self-producers of various sizes, who, together, produce about one-fourth of the total quantity of electricity consumed in the country, i.e. about 70 GWh. Approximately 40 GWh of this amount is produced by five medium-size industrial plants, the rest being produced by extremely small self-producers.

3. At present, about 85% of the electricity is produced by diesel plants, the fuel for which is imported at a high price (because of the cost of road transport from the ocean ports more than 1,000 km away). About 4% of the total electricity production comes from the use of local fuels by the self-producers, including agro-industrial biomass waste. The remainder, i.e. about 11%, comes from hydroelectric production. This is handled by the 14 MW Kompienga plant, which came into service in 1989 and which has yet to reach its installed average annual production level. During the next few years, once the new 16 MW hydro plant in Bagré comes into service (1993), hydro electricity will amount to between 65 and 70 GWh per year on average and will thus cover about one quarter of total consumption.

4. One of the basic characteristics of the sector is the high price of electricity (CFAF 85/kwh on average in recent years, which is one of the highest in all the countries of the region). This is attributable, in particular, to the high price of fuel for the diesel plants, as mentioned earlier, but is also because of the large investments made during the last decade in the development of hydroelectric production, the natural conditions for which are not particularly favorable in Burkina. It should also be noted that the high price indicated above is less than the supply cost. SONABEL actually receives a large amount of financial support from the Government, in the form of fiscal relief, a subsidy on the fuel consumed by the power plants and the Government's assumption of 70% of the debt contracted for the construction of the Kompienga hydro plant. The real cost of electricity, taking all costs into account (excluding taxes) is approximately CFAF 10 more than the selling price.

5. The power system operated by SONABEL comprises three subsystems: (i) the central network supplying the capital city Ouagadougou, the city of Koudougou about 100 km away and a few outlying communities; (ii) the western region network, currently being established, with the city of Bobo Dioulasso as its main center; and (iii) a dozen or so secondary centers, customarily supplied by a diesel plant of some hundred kW. The latter together consume about 7% of the total amount of electricity distributed by SONABEL, while the two main cities of Ouagadougou and Bobo Dioulasso consume about 85%. The generation costs differ considerably between the secondary centers, where the diesel sets operate on gas-oil (or DDO), and the main centers, where heavy fuel is used.

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2. For comparison purposes, the per capita consumption figures in kWh/year are as follows for some countries: Gabon 700, Mauritius 450, Cameroon 200, Senegal 100, Cape Verde 70, Tunisia 600, China 500, India 290, Indonesia 240.

6. SONABEL is organized rationally and operates in a relatively satisfactory manner, particularly where the distribution network operations and customer management are concerned. It is worth noting that the total losses of the networks are less than 10%. However, overall personnel productivity, i.e. 0.16 GWh/employee, which has remained the same or slightly lower during the past decade, is mediocre and would indicate the need for better staffing management.

7. In terms of its institutional position, SONABEL operates under the supervision of the Government, which appoints the members of the Board of Directors, sets tariffs for the sale of electricity and approves development plans. As owner of the company, the Government has also to approve the accounts presented by the Board of Directors. It should be pointed out here that SONABEL enjoys a certain autonomy of management which could be strengthened by institutionalizing a formula for the independent audit of SONABEL's accounts and financial statements.

8. The Government's policy for the electricity sector assigns priority to nationwide electrification, so as to make electricity accessible to a higher proportion of the population and facilitate the development of the modern sectors of the economy. The Government is, at the same time, anxious to reduce the country's dependence on imported energy. The desire to develop national energy resources and hydroelectric power, in particular, should, however, remain secondary to the objective of providing the country with lower-cost electricity. With this in mind, opportunities to import electricity at competitive prices from Ghana or Côte d'Ivoire should be explored and utilized in a more systematic manner.

Increase in demand

9. The average annual rate of increase in the consumption of electricity distributed by SONABEL has been 9% over the last 20 years. Between 1983 and 1986, consumption remained stationary, but since 1986 there has again been a steady increase (8.3% on average during this latter period), which is not often found in most countries in the subregion. The increased demand reflects, in part, the progress of the modern sector of the Burkina Faso economy and, above all, a social need of the population which aspire to improve their living conditions. If the rate of increase is maintained at such a high level, a special effort will be needed to control and rationalize demand, in general, and demand for air-conditioning and lighting, in particular.

10. The studies made by SONABEL and several consulting firms to forecast demand show that for the next two decades an increase in demand averaging between 6 and 8% per annum can be expected, this increase being dependent not only on the development of the country's economic activities but also on how rapidly electrification progresses.

Management of SONABEL

11. The main management problems identified in the course of this sector development review concern: (i) the age of some of the diesel-fueled thermal generating equipment; (ii) personnel productivity which is low even compared to similar companies within the region; (iii) the alarming increase, in recent years, in customer debts and in amounts owed by the public sector and government agencies, in particular; and (iv) the fact that SONABEL does not fund the repayment of the debts contracted in connection with the construction of the Kompienga hydroelectric development project.

12. SONABEL's thermal power plant equipment is of two different types: (1) in the two main cities, Ouagadougou and Bobo Dioulasso, most of the generating sets have a unit capacity of between 1 MW and 7.6 MW, two-thirds of the installed capacity of this type operating on heavy fuel; and (ii) in the secondary centers most sets have a unit capacity of less than 300 kW. More than 90% of the small sets are relatively new (less than 10 years old), while most of the equipment in the two main plants is old (80% of the capacity installed in these plants being over 13 years old). Given these circumstances, it is clear that the maintenance and repair of the equipment is becoming increasingly costly (expenditure on spare parts has multiplied ninefold in five years), which raises the issue of the need to decide without delay to appropriately rehabilitate the equipment that can be rehabilitated and to decommission the units that are too old.

13. With respect to technical quality, SONABEL operates relatively well in terms of both its power plants and its distribution networks, including the network expansion work, construction of lines, stations, etc. The enterprise has a training school, which enables it to maintain and update the skills of its personnel.

14. Additional efforts are needed, however, in order to improve overall personnel productivity. In recent years, in fact, although the average real wage of SONABEL's personnel has increased substantially, this has not brought about a corresponding improvement in overall personnel productivity and has increased the cost per kWh sold.

15. The increase in the production cost per kWh over the last five years has remained relatively moderate, thanks, in particular, to the preservation or even reduction, of the biggest item of expenditure, i.e. fuel. It should be mentioned here that SONABEL has made satisfactory arrangements with respect to procurement, and that the Government has given the company favorable treatment in the form of major fiscal relief and even a small subsidy on fuel for use by the plants.

16. With respect to customer management, the Distribution Department conducts an efficient operation in terms of both regular billing of electricity consumed and treatment of new subscribers. But in recent years, the customer debt account has, at the same time, been increasing at a rate of close to CFAF 2 billion each year. The main items in the customer account are Central Government and Government arrears.

17. In the secondary centers and the newly electrified districts, SONABEL is undertaking promotional activities to encourage applications for new connections and thereby to increase at a fairly rapid rate the charges collected from the new networks so as not to extend the deficit period which generally characterizes the early years of operating a network.

18. In certain recent housing developments, in Ouagadougou and Bobo Dioulasso in particular, SONABEL is experiencing a problem that is quite the opposite: it is unable to meet all the applications for connections because of a lack of funds to finance the corresponding extension work. What is happening is that the budget that the company has been able to allocate for this purpose has been limited to CFAF 200 million/year in recent years, which has proved insufficient and has led to an accumulation of unsatisfied applications totaling CFAF 1.2 billion. For 1993 SONABEL increased the budget for network expansion to CFAF 800 million.

19. SONABEL's <u>financial situation</u> has changed considerably in recent years, since the Kompienga hydroelectric plant came on line, its fixed assets, totaling CFAF 36 billion, accounting for

over half the company's current balance sheet. The corresponding amortization, amounting to CFAF 1.14 billion/year, is not offset by the savings in fuel costs brought about by the hydroelectric production of Kompienga, which has meant an increase in the overall production cost per kWh. SONABEL's financial results have not suffered in this respect, however (it regularly makes a profit), because only a small part of the debts contracted for Kompienga is directly paid by SONABEL, most of the corresponding debt being borne by the Government. Sound management would require that all the costs incurred in supplying its customers with electricity be reflected in SONABEL's accounts and that the tariffs be adjusted accordingly. But this would mean increasing the sale tariffs, which are already very high (para. 4 above) from CFAF 5 to CFAF 6/kWh, which has been viewed by the Government as untenable by the country's economy.

20. This present treatment of its debt should have given SONABEL a wide self-financing margin and enabled it to participate to a substantial degree in the financing of its investment program. But the run-away increase in the customer debt account, as mentioned above, has made a large proportion of this margin unusable.

The development program

21. The sector development program, adopted by SONABEL and approved by the Government, is based on the study of the "Master Plan for the Electrification of Burkina Faso," prepared in 1987 with the assistance of the consulting firm Coyne & Bélier. This important document, which is based on a long-term approach, is used as a reference for the *ad hoc* studies and updating work periodically undertaken by SONABEL, preparatory to decisions on the individual projects it plans to carry out. It should be mentioned, however, that (i) this 1987 master plan does not really provide an economically optimal investment sequence; and (ii) in any case, a document of this type needs to be revised periodically (every four or five years) to reflect any economic and technical changes that have occurred. This is particularly true when evaluating hydroelectric potential and its cost and also when assessing opportunities for importing electricity at a competitive price.

22. The above-mentioned master plan gives priority to the development of hydroelectric resources, which are practically the only significant national primary energy source for electricity production. The main project studied, i.e. Noumbiel (180 to 200 GWh/year), situated on the Mouhoun River (Volta Noire) in the area where it borders on Ghana, uses hydroelectric resources, half of which are owned by Ghana and half by Burkina Faso. It will therefore be possible to carry out this project only if both parties are interested in doing so. Unfortunately, the Noumbiel dam would result in water loss from evaporation between about 500 and 800 million m^3 per annum, resulting in production losses of between 90 and 130 GWh at the existing plants at Akosombo and Kpong, situated in Ghana. A certain reservation on the part of Ghana toward the Noumbiel project is therefore to be expected, although the positive effect of river regulation, thanks to this project, would also brings gains of about 60 GWh for the future Bui project, which is also located in Ghana. The complexity of this problem leads to the conclusion that the feasibility of the Noumbiel project will have to be demonstrated from an overall standpoint, taking all the different interests involved into account.

23. As for other hydroelectric development projects, it should be pointed out that there is no inventory of the country's hydroelectric resources on which to base optimal planning of future projects. A water resource development study is therefore needed, which will have to evaluate hydroelectric production costs and take account of the fact that it will, in many cases, be necessary to

plan multipurpose development projects (e.g. hydro-agricultural projects, as in the case of the Bagré project, which is currently under way).

24. The country does not have any other primary energy resources with proven potential for electricity generation. Further technical research would be needed in order to clarify the possibilities for using the graphite shales in the area surrounding Kaya, which were discovered in the course of recent works in connection with the UNDP geological cartography project in Burkina Faso.

25. Given the limited and uncertain nature of Burkina's energy resources for electricity generation, one can only conclude that thermal production based on imported fuel remains the solution of reference (in that any other solution will have to be better in order to be acceptable). Development of this production will, of course, have to be studied carefully in order to determine the most beneficial type of equipment, unit capacity and installation schedule.

26. The most promising alternatives for Burkina Faso seem to be those offered by interconnection with neighboring countries and specifically with Ghana and Côte d'Ivoire. In these two cases, the electric energy that could be supplied to Burkina would be more economical than local diesel production. Among the factors determining the feasibility of such interconnection projects, one that needs to be clarified is whether or not the exporter country is able to commit to a long-term supply arrangement or merely to the occasional supply of surplus energy.

27. The development of transport networks depends to a large extent on which solutions are adopted for the production (or importation) of electricity. If diesel production is to predominate, the centers of consumption can be supplied without the need for a major development of transport networks. On the other hand, if the electricity is going to come from hydroelectric production or imports, transportation will have an important role to play. At the present time the necessary information has not yet been collected to be able to make a clear choice of one strategy over another. For this reason, the extremely large-scale development of transport networks that is included in the 1987 Master Plan in connection with the development of hydroelectric production, is just one possible variant of the study.

28. The development of the distribution networks will have to move toward a more advanced standardization of the construction and equipment solutions, which will be reflected in the simplification of the operation, the reduction of stocks of equipment and spare parts and, finally, in a reduction of total distribution cost. The strategy of this development will have to be carefully defined, because it involves a very long period of time, i.e. several decades. With this in mind, the most urgent task is to standardize the studies and rural electrification works, where SONABEL already has valuable experience.

29. All the aspects mentioned in the foregoing paragraphs will have to be taken into account in order to arrive at a global approach aimed at formulating an optimal development program which will be able to ensure that demand for electricity is met at the lowest total cost to the Burkina at large. Preparation of such a program will be done gradually, reaching increasing levels of integration and refinement, as the basic data and project hypotheses become better managed. Initially, the optimal program will only consider those generating plants and international interconnections that need to be decided on as a matter of urgency.

30. The optimal development strategy formulated as indicated above will have to be supplemented by a coherent set of accompanying measures all geared toward the same basic objective, i.e. to reduce the cost of electricity supplied to consumers. This will call for: (a) launching programs of action to bring about more efficient utilization of electricity for the various purposes for which it is used and for air-conditioning and lighting, in particular; (b) introducing tariff formulae that are more likely to encourage subscribers to consume electricity in a manner that is more cost-efficient for them and more energy-saving for the country as a whole; (c) improving SONABEL'S management at all levels and above all, getting personnel costs under control.

31. Opening of the sector to other operators besides SONABEL should also be envisioned in a spirit of economic competition and electrification expansion. This might attract some new private operators, consumer cooperatives (as in the case of rural electrification) or the self-producers, who would be authorized to sell their surplus to distribution customers.

Urgent tasks - some suggestions for a short-term action plan

32. (a) Improve operations

- Organize the monitoring of fuel consumption by generating unit; then introduce a procedure for establishing the running schedule for the sets and for distributing the load so as to minimize overall fuel consumption.

- Study customer motivation with a view to better adapting the tariff formulae and connection-related arrangements.

- Have SONABEL's accounts and financial statements audited by an experienced consultant in order to improve the handling of accounting and financial data and of management procedures in general.

33. (b) Strengthen SONABEL's autonomy and give it more responsibility

- Clarify the financial relationship between the Government and SONABEL by (i) gradually making SONABEL responsible for all Kompienga debts; (ii) settling the arrears owed by the Government; (iii) strict measures ensuring that the Government and public agencies pay their electricity bills regularly.

- Study and formulate a tariff indexing system

- Formulate performance indicators for operations and, based on these, establish a *Contrat-Plan* between SONABEL and the Government and procedures for monitoring/ control/arbitration to ensure that it is diligently complied with by all the parties concerned.

34. (c) Ensure harmonious and effective development

- Help SONABEL establish an elaborate planning methodology using efficient and appropriate models and tools.

- Organize, targeting young SONABEL managers with good basic education, specialized training in the planning of power generation and networks expansion; involve them in the work done by the consultants hired to prepare projects for Burkina Faso.

- Launch a study on the current status of the thermal equipment of the plants in Ouagadougou and Bobo Dioulasso in order to identify the sets that need to be rehabilitated and those that should be decommissioned. Based on the findings, formulate an emergency rehabilitation program.

- Analyze, with other countries of the region, possibilities for producing and importing/exporting electricity with a view to deciding on the advisability of international interconnections and incorporating them into the development plans.

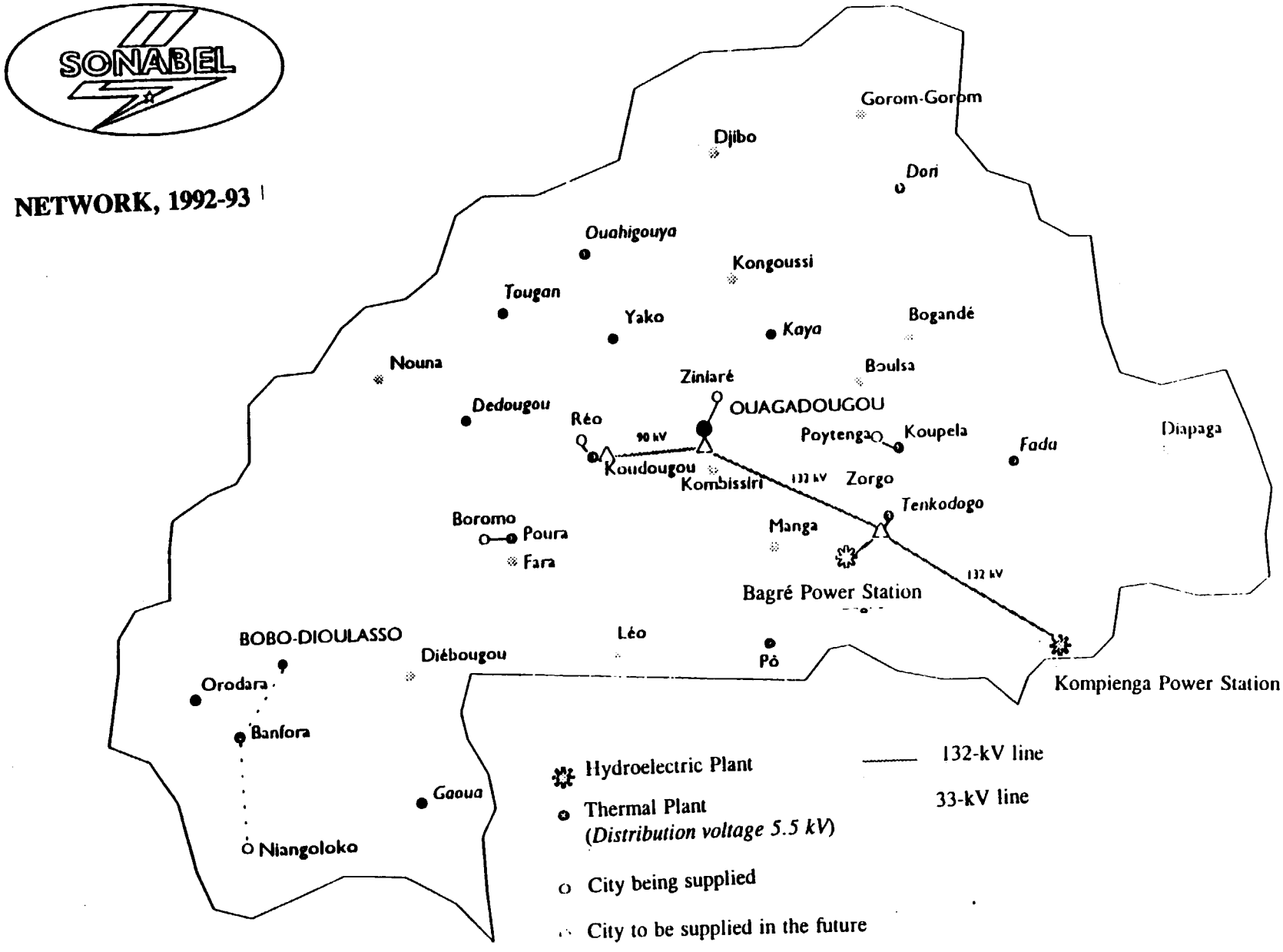
SONABEL
NETWORK, 1992-93
Gorom-Gorom
Djibo
Dori
Ouahigouya
Kongoussi
Tougan
Yako
Kaya
Bogandé
Nouna
Boulsa
Zinaré
OUAGADOUGOU
Dedougou
Réo
90 kV
Koudougou
Kombissiri
132 kV
Zorgo
Poytenga
Koupela
Fada
Diapaga
Tenkodogo
Boromo
Poura
Fara
Manga
Bagré Power Station
132 kV
BOBO-DIOULASSO
Diébougou
Léo
Pô
Kompienga Power Station
Orodara
Banfora
Gaoua
Niangoloko
Hydroelectric Plant
Thermal Plant
(Distribution voltage 5.5 kV)
City being supplied
City to be supplied in the future
132-kV line
33-kV line

Figure 1

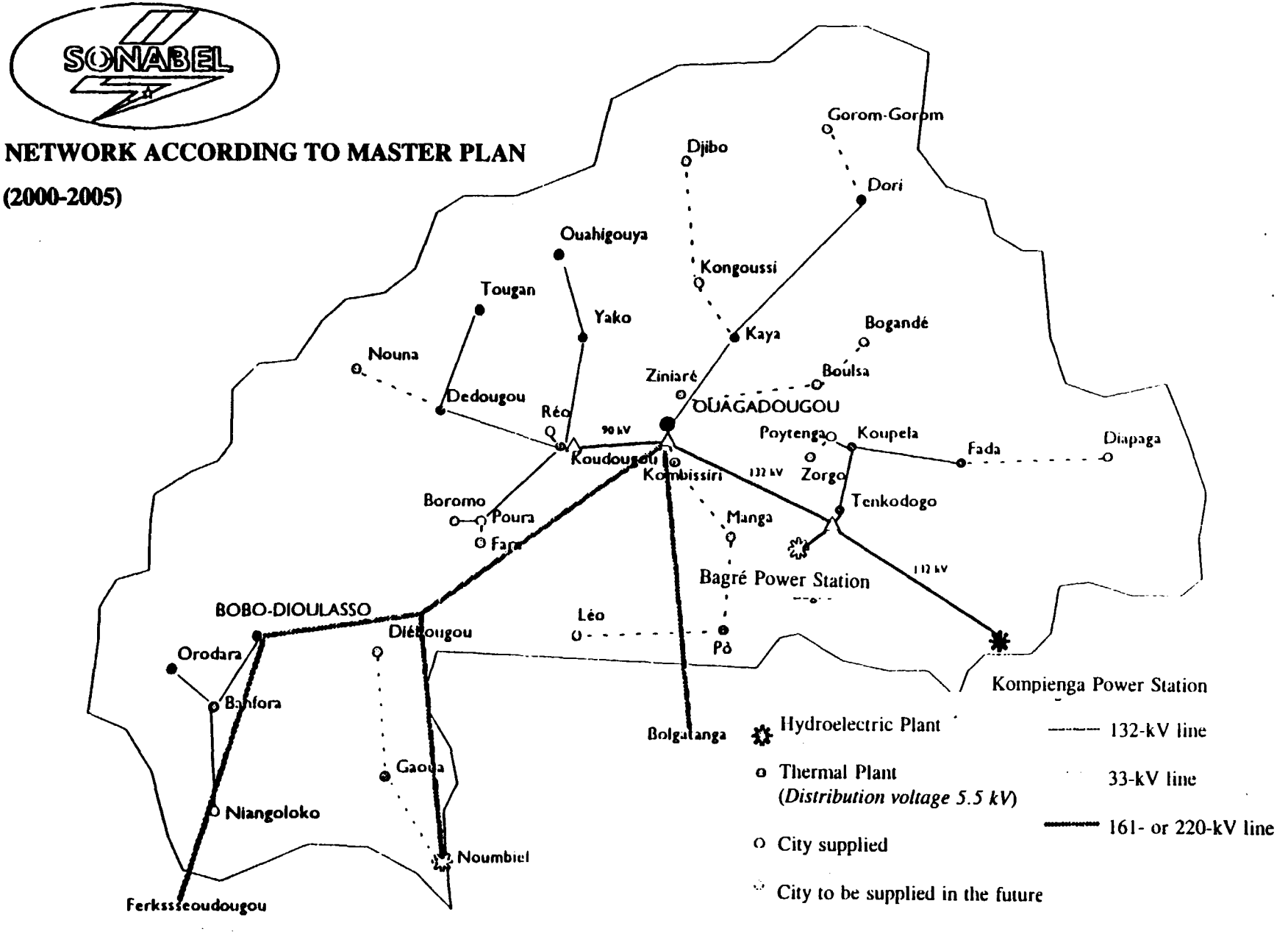
SONABEL
NETWORK ACCORDING TO MASTER PLAN
(2000-2005)
Gorom-Gorom
Djibo
Dori
Ouahigouya
Kongoussi
Tougan
Yako
Kaya
Bogandé
Nouna
Boulsa
Ziniaré
Dedougou
OUAGADOUGOU
Réo
90 kV
Koudougou
Kombissiri
132 kV
Poytenga
Koupela
Fada
Diapaga
Zorgo
Tenkodogo
Boromo
Poura
Manga
Bagré Power Station
112 kV
BOBO-DIOULASSO
Léo
Diébougou
Pô
Orodara
Banfora
Kompienga Power Station
Bolgatanga
Gaoua
Niangoloko
Noumbiel
Ferkssseoudougou
Hydroelectric Plant
Thermal Plant
(Distribution voltage 5.5 kV)
City supplied
City to be supplied in the future
132-kV line
33-kV line
161- or 220-kV line

Figure 2

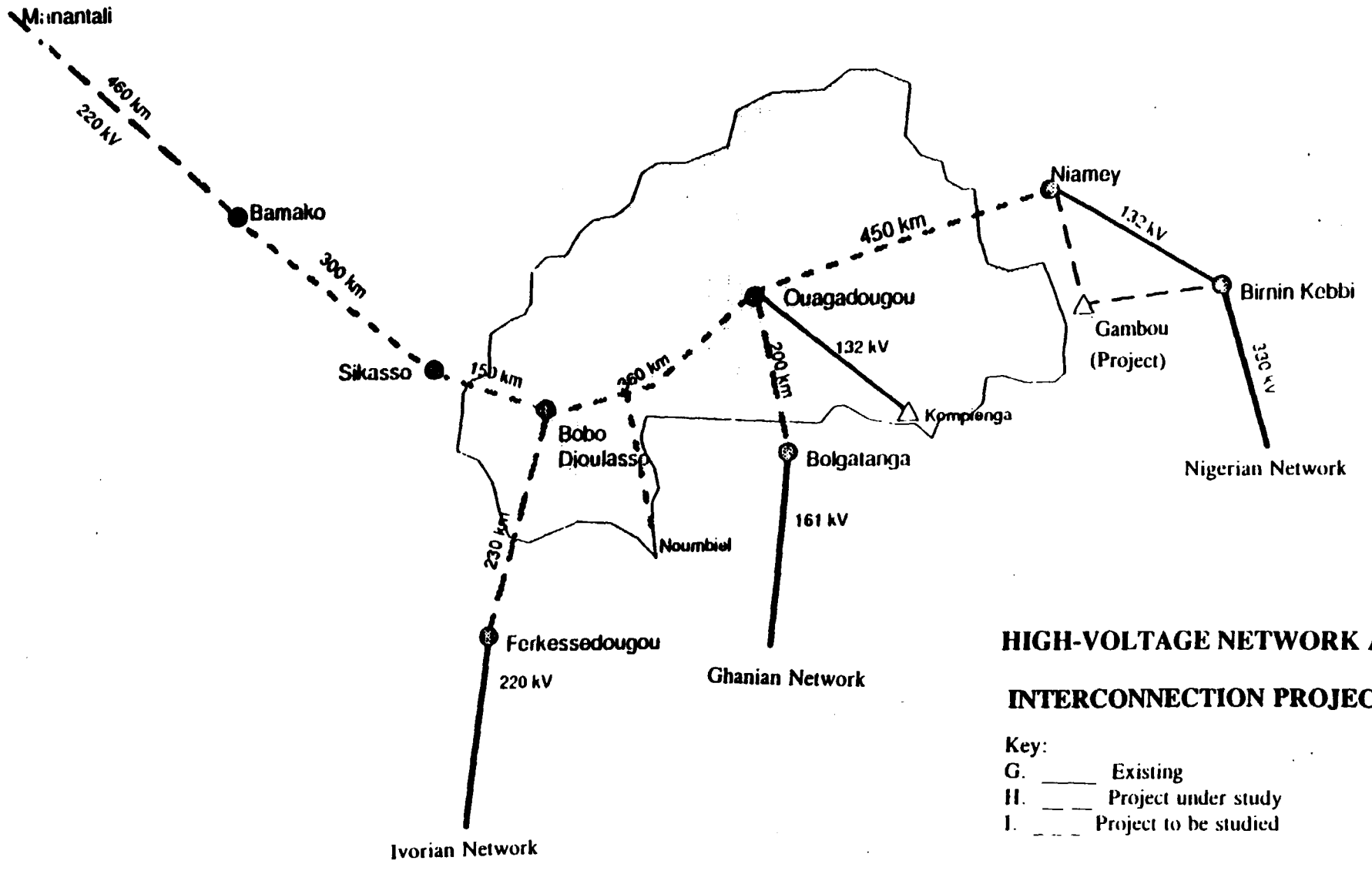
Manantali
460 km
220 kV
Bamako
300 km
Sikasso
150 km
Bobo
Dioulasso
360 km
Ouagadougou
450 km
Niamey
132 kV
Birnin Kebbi
Gambou
(Project)
330 kV
Nigerian Network
132 kV
Komprenga
200 km
Bolgatanga
161 kV
Ghanian Network
Noumbiel
230 km
Ferkessedougou
220 kV
Ivorian Network
HIGH-VOLTAGE NETWORK AND
INTERCONNECTION PROJECTS
Key:
G. _____ Existing
H. _ _ _ Project under study
I. _ _ _ Project to be studied

Figure 3

I. GENERAL FRAMEWORK OF THE ELECTRIC POWER SECTOR

A. Profile of Burkina Faso

1.01 Burkina Faso is a landlocked country in the heart of West Africa. It is a flat country with a lateritic soil; its vegetation is predominantly brush and scrub. In the Northern region, the country becomes sahelian. The capital, Ouagadougou, is located in the transition zone between the tree and shrub savanna zones. In the South, in the Banfora region, rainfall is greater and there are forests and irrigated fields where sugar cane is grown. Burkina Faso has an area of 274,000 km^2. It is bordered on the north and west by Mali, on the northeast by Niger, on the southeast by Benin and on the south by Togo, Ghana and Côte d'Ivoire. The average elevation of the plateaus is 500 m; the highest point--the Tenakourou, located in the eastern part of the country--is 747 m. Burkina Faso is traversed by three major rivers: the Mouhoun, Nazinon and Nakambe. All three flow into Lake Volta in Ghana, created by the Akosombo hydroelectric power station dam.

Climate

1.02 Thanks to its geographic location in the Sudanian zone, Burkina Faso enjoys a tropical climate with two seasons, a dry season from November to April and a rainy season from May to October. The period from November to March is marked by the Harmattan, a dust-laden wind. Annual rainfall is 300-400 mm in the North region and 1100-1200 mm in the South.

B. Population

1.03 In 1992 Burkina Faso had a population of about 9.6 million, giving an average density of 35 people per square kilometer. The annual population growth rate is currently about 3 percent. Studies by the National Institute of Statistics and Demography indicate that this rate will hold up, with slight variations, over the next two decades. The population will reach nearly 18 million by 2015.

Population density, housing

1.04 Population distribution by region is fairly uneven, as the appended map shows. Population density is lower in the eastern regions of the country (under 10/km^2), while in the central regions, notably Kouritenga and Kadiogo, it exceeds 100/km^2.

TABLE 1

Population of Burkina Faso
(000s)

Actual		Projection	
1950	3 770	1995	10 456
1960	4 400	2000	12 038
1970	5 380	2005	13 812
1975	5 638	2010	15 733
1980	6 988	2015	17 790
1985	7 965		
1990	9 126		
Average Annual Growth Rate (%)			
1950-1975	1.62	1995-2005	2.80
1975-1980	3.51	2005-2015	2.60
1985-1990	2.70		

Source: National Institute of Statistics and Demography.

1.05 Most of the population live in small rural localities. According to the 1985 General Population Census, about 85 percent of the people live in localities with under 10,000 inhabitants.

1.06 The urbanization rate is very low (of the order of 10 percent); it is difficult to quantify since it depends on the criteria used to define urban localities. In Burkina Faso it has been agreed to distinguish between rural and urban localities by reference not to size but to development level (potable water distribution, electricity, existence of schools, medical units, and so on). Thus, in 1975 only the five localities classified as urban (Ouagadougou, Bobo Dioulasso, Koudougou, Ouahigouya and Banfora) were electrified. In 1985 another 13 localities were added to this list, most of which were electrified between 1983 and 1986.

TABLE 2

Distribution of Resident Population, by Province
(1975 and 1985 census figures)

Province	1975 Population		1985 Population	
	Number	Density	Number	Density
Bam	145 767	36	162 575	40
Bazega	217 840	41	303 941	57
Bougouriba	177 304	25	220 895	31
Boulgou	277 345	31	402 236	45
Boulkiemde	310 989	75	365 223	88
Comoe	175 422	10	249 967	14
Ganzourgou	124 638	30	195 652	48
Gnagna	146 574	17	229 152	27
Gourma	168 585	6	294 235	11
Houet	308 670	19	581 722	35
Kadiogo	184 590	158	459 826	393
Kenedougou	98 718	12	139 973	17
Kossi	203 357	14	332 960	25
Kouritenga	144 035	89	198 486	122
Mouhoun	200 026	19	288 735	28
Nahouri	73 485	19	105 509	27
Namentenga	130 429	17	198 890	26
Oubritenga	252 620	54	304 265	65
Oudalan	74 853	7	106 194	11
Passore	218 529	54	223 830	55
Poni	180 288	17	235 480	23
Sanguie	173 442	34	212 277	42
Sanmantenga	283 776	31	367 724	40
Seno	146 073	11	228 905	17
Sissili	120 391	9	144 919	18
Soum	133 153	10	186 812	14
Sourou	232 377	24	268 108	28
Tapoa	92 056	6	158 859	11
Yatenga	530 192	43	536 578	44
Zoundweogo	112 670	33	155 777	45
BURKINA FASO	5 638 203	21	7 694 705	29

FIGURE 4

BURKINA FASO: Population Denstiy, by Province, 1985

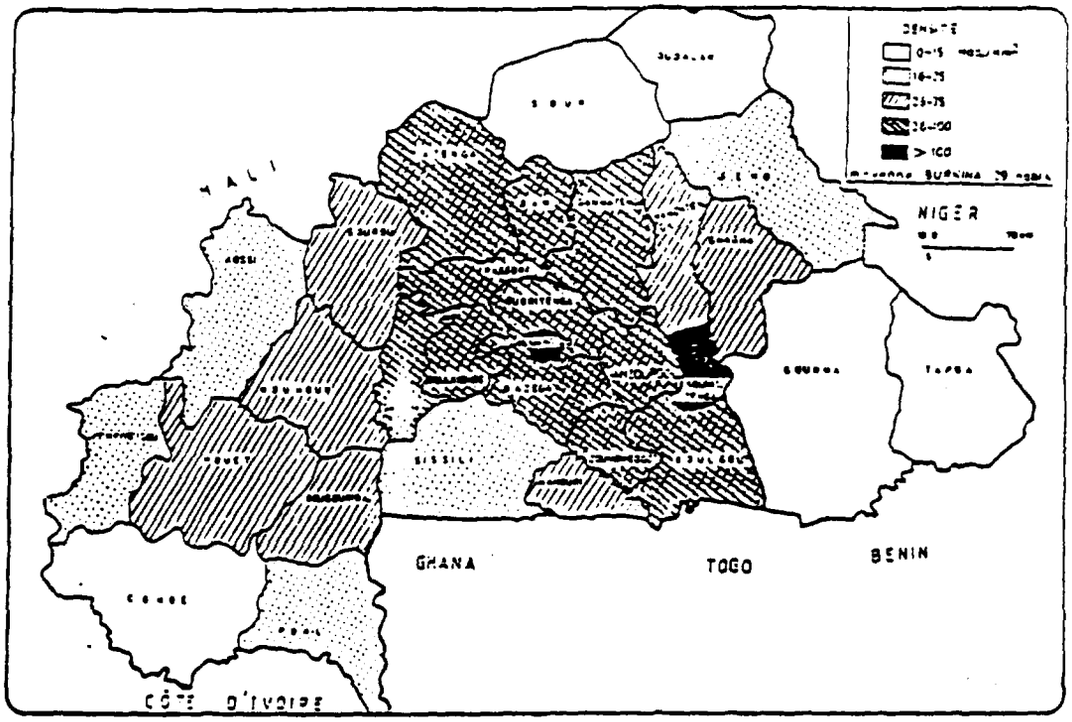

TABLE 3

Population of Urban Centers, 1986
(000s)

Center	000	Center	000
Ouagadougou	441.5	Reô	18.5
Bobo Dioulasso	228.7	Nouna	15.2
Koudougou	61.9	Po	14.2
Ouahigouya	39.0	Yako	14.2
Banfora	28.3	Gouray	14.4
Kaya	25.2	Orodara	13.0
Tenkodogo	23.3	Tougan	12.6
Dedougou	21.0	Dori	11.0
Fada N'Gourma	20.9	Gaoua	10.7

1.07 The two major urban centers, Ouagadougou and Bobo Dioulasso, have experienced substantial population growth during the last few years, with annual rates of the order of 8 percent. Large-scale subdividing operations, carried out in main localities from 1984-85 onward, have created new neighborhoods which are still developing. The 1985 census shows average household size as 7 persons for the country as a whole but 5.5 persons in urban areas. As a rule, 3 or 4 households live grouped together in a "concession," particularly in the rural areas.

C. Economy

1.08 Burkina Faso belongs to the less developed countries group. Its GDP was only US$290 per capita in 1992. The economy is based on farming and herding, which contribute about 40 percent of GDP and employ nearly 90 percent of the population. The major agricultural products are sorghum and millet, which form the traditional basic diet of the rural population. Industrial development centers chiefly on agroindustries that process cotton, groundnut, sugar cane, karite (shea), etc. All manufacturing industries together contribute about 17 percent of GDP with construction and public works sector, which had developed greatly in the 1980s, accounting for nearly 10 percent of GDP. Trade and business, transportation and services and other non-mercantile activities together contribute above 35 percent of GDP. GDP growth was fairly strong over the period 1980-88 (average annual rate 5.5 percent) but slowed in 1989-92 (to around 2 percent).

1.09 A major economic asset of Burkina Faso is its membership of the West African Monetary Union (WAMU). WAMU manages the common currency, the CFA franc, which is linked to the French franc by a guaranteed fixed parity. This ensures a degree of price stability and offers conditions of monetary security attractive to investors. Since 1985, however, a rapid appreciation has taken place in Burkina's real exchange rate as well as those of the other countries of the CFAF zone. This resulting deterioration in the competitiveness of these countries in terms of relative prices is cause for concern.

1.10 Burkina Faso is also a member of the two regional economic organizations, the West African Economic Community (WAEC), comprising the French-speaking West African countries, and the Economic Community of West African States (ECOWAS), which comprises all the West African countries. Note that by virtue of these regional agreements Burkina Faso enjoys substantial financial support deriving from savings of emigrant workers in the other coastal countries (notably Côte d'Ivoire).

Modernization of the economy

1.11 The development of infrastructures and of the modern sector of the economy has been fostered during the last few years by a relatively high investment rate (averaging 23 percent of GDP over the period 1986-92). Through 1990, this was accounted for in large part by public investment in the execution of major works projects (including the Kompienga and Bagré dams). The Government of Burkina Faso is actively studying the implementation of far-reaching reform of the country's economic structures, including phased privatization of competitive-sector activities.

D. Energy Sector

1.12 Burkina Faso's energy resources base is fairly limited. The major domestic resource is biomass, with firewood as its main source, together with harvest and animal residues. The country's hydroelectric potential is estimated at 90 MW, though no systematic study has yet been done. A 14-MW power station, Kompienga, entered into service in 1989 and a second one, Bagré, with a capacity of 16 MW, is under construction. The largest potential is located at Noumbiel on the Mouhoun River (Volta Noire) in the area where it forms the border with Ghana; however, development of this site remains uncertain owing to its possible adverse impact on the Akosombo power station and the Bui project in Ghana. There are moreover alternative projects to Noumbiel. While these are located entirely within Burkina Faso, their capacity is lower than that of Noumbiel. Petroleum products provide the main primary source of electricity generation: gas oil, DDO and fuel oil (FO). While these are entirely imported at the world market price, their c.i.f. prices are heavily inflated by land transportation costs to Burkina Faso from Togo, Benin or Côte d'Ivoire ports. In the Kaya region there are deposits of graphite and carbonaceous black shales. One site, Datari, is being studied by the UNDP project (mining research project) for possible utilization as a fuel material.

1.13 Burkina Faso's energy needs, which total about 2 million toe,[3] are met mainly out of non-commercial sources (firewood and plant waste), which account for 90 percent of total gross consumption, while commercial sources (petroleum products and electricity) account for only 10 percent. Table 6 shows Burkina Faso's general energy balance for 1990. Gross consumption of energy from commercial sources was 202.4 ktoe in 1990, i.e. only 22.2 kg per inhabitant, which is characteristic for the country's low level of industrialization. Note that this energy derives 99.6 percent from imports, in the form of petroleum products. A large part of it (57 percent) goes to the transportation sector. Households consume 8.6 percent, in the form of lamp oil and gas, and industry, agriculture and services together 6.3 percent. The share of imported petroleum products used for electricity generation is 27 percent. In these circumstances, it is clear first that the need for development of the modern sectors of the economy will generate a growth of energy demand sustained over a long period, and second that the cost of this energy will be boosted durably by the high delivered cost of imported petroleum products due to the long land trip between the ocean ports and Burkina Faso.

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[3] Ton of oil equivalent.

TABLE 4

Energy Balance Structure, 1990
(ktoe)

	Non-Commercial Energy	Electricity	Petroleum Products	Total
Primary Energy				
• Domestic production	1 925	0.8		1 925.8
• Imports			201.6	201.6
Total				2 127.4
Conversions				
• Electricity generation	(4)	20.4	(54.4)	(38.0)
• Charcoal production	(12)			(12)
Total Available	1 909	21.2	147.2	2 077.4
Losses		2.0		2.0
Consumption				
• Households	1 863	4.2	17.4	1 884.6
• Transportation			117.1	117.1
• Industry, agriculture, services	46	15.0	12.7	73.7

Source: Mission assessments.

Institutions

1.14 The following are the government institutions and departments involved in coordination and supervision of the energy sector in Burkina Faso:

- The Ministry of Industry, Trade and Mining (MICM), with a Delegated Minister responsible for Energy and Mining (MDEM), who has jurisdiction over the two main energy-sector companies:

  - Société Nationale d'Electricité du Burkina (SONABEL) (electric power);
  - Société Nationale Burkinabé d'Hydrocarbures (SONABHY) (hydrocarbons).

Within the MDEM, the activities of the energy sector as a whole form part of the responsibilities of the Directorate General of Energy and Mining (DGEM).

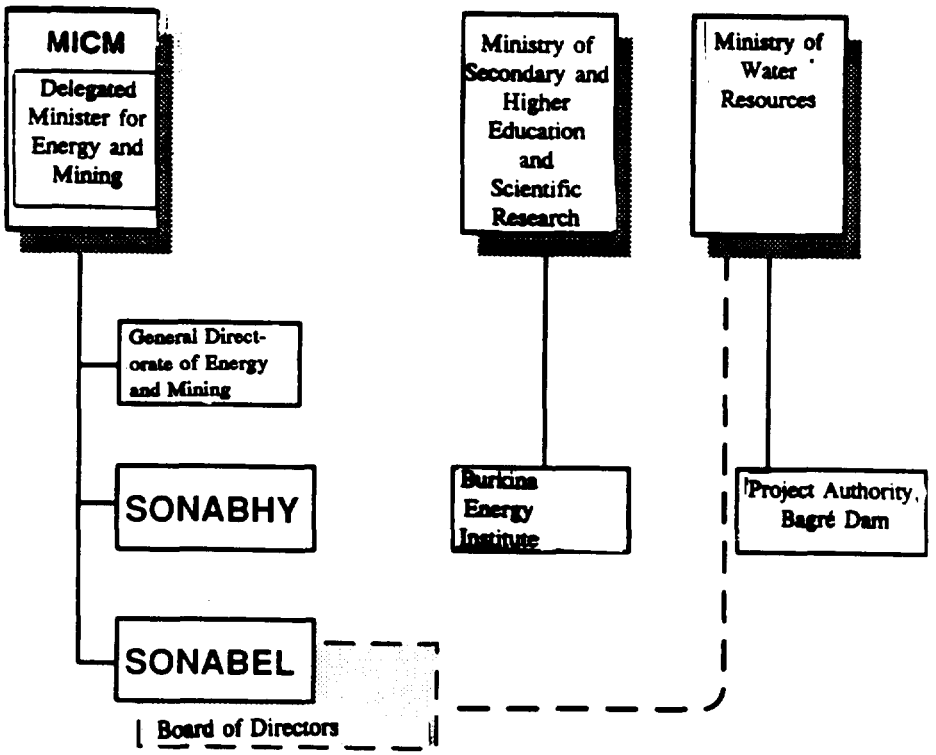
- The Ministry of Environment and Tourism (MET), within which the General Directorate of Environment (DGE) (Directorate of Village Forestry and Forest Development) is responsible for the development of firewood and charcoal production.

- The Ministry of Secondary and Higher Education and Scientific Research (MESSRS), with the Burkina Energy Institute (IBE).

- The Ministry of Water Resources (ME), which is responsible for designing river development so as to meet the water needs of the economy and the population and at the same time, wherever possible, generate electricity.

FIGURE 5

Energy-Sector Institutions



1.15 Concerning energy prices, note that hydrocarbons are among the products whose prices are regulated; they are set by an Order (*Arrêt*) of the Ministry of Trade. Management of the petroleum subsector is entrusted to SONABHY, which is accordingly responsible for preparing and documenting requests for approval of price structures, which comprise *inter alia* the following data:

- the f.o.b. supplier price;
- the calculations for the various price structure components: duties and taxes, security stock,[4] transportation costs, petroleum company costs and margin, SONABHY costs and margin, including transfer to storage, equalization charge (*péréquation*) and city retail price.

The General Inspectorate of Prices and Economic Affairs (*Inspection Générale des Prix et des Affaires Economiques--IGPAE*) is the technical department responsible for price review. It is assisted by a Price Approval Technical Commission (*Commission Technique d'Homologation de Prix*). The Commission meets to examine the data furnished by SONABHY; if price revision is justified, the General Inspectorate is empowered to draw up a Ministerial Order on the composition of price structures and levels, which is submitted to the Minister of Trade for approval and signature.

1.16 The company SONABEL is the sole distributor of electricity in Burkina Faso. SONABEL is a public establishment, and consumer electricity rates are established by means of an entire preparation and approval procedur culminating in the final decision by the public authorities. Electricity rates can be reviewed whenever SONABEL's accounts fall out of balance. In that event, after consulting the public authority, SONABEL performs a tariff study, proposes solutions and then submits the documented application to the Government for decision. Preparation of the electricity rates tariff is based on petroleum prices and SONABEL's investment program for development of the generating facilities and infrastructures included in the Electrification Master Plan. The current tariff structure is based on long-term marginal cost. The rates include a fixed premium and energy prices; the latter may differ according to the time of day. The rates are the same throughout the country. The Government regards this national equalization as essential for the development of electrification of the country. The tariff level must be affordable by the average consumer and at the same time safeguards SONABEL's interests. Both the public authorities and SONABEL monitor this requirement, and prices are directly controlled by the Administration.

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[4] SONABHY is responsible for managing the security stock to ensure that the country possesses at least a stock of each product equal to at least 90 days consumption.

II. ELECTRICITY DEMAND

Development and structure of consumption

2.01 The status and trend of electricity demand is one of the basic parameters of development of the electric power sector as a whole. Historical analysis of demand level and structure provides a picture of gross demand trends. It thus provides a frame of reference for projecting the consumption levels that development of the system will be required to satisfy.

2.02 Some 20 localities currently possess public electricity distribution service, operated by the national company SONABEL. Electrification came relatively recently to most of them (less than ten years ago) and their consumption is low. The country's two major cities, Ouagadougou and Bobo Dioulasso, together account for about 85 percent of total electricity distribution volume in Burkina Faso.

TABLE 5

Electricity Sales, 1991

Center	GWh	%
Ouagadougou	103.55	61.2
Bobo-Dioulasso	40.06	23.7
Koudougo	11.85	7.0
Banfora	1.81	1.1
Other Centers	11.86	7.0
TOTAL	169.13	100.0

2.03 It should be noted however that the above total does not include the electricity generated by certain industrial, agricultural or private self-producers in non-electrified localities. These amounts are not known precisely since statistics are not kept. Their total can be estimated very approximately at some 60-63 GWh/year, 20 percent of which is generated using biomass waste in agroindustry (see paras. 4.16 through 4.22).

2.04 Over the past two decades electricity generation and sales by SONABEL have grown at an average annual rate of 9.1 percent. Growth has not however been even over the period. The rapid growth during the ten-year period 1972-82 was followed by a pause due to the political and economic upheavals of 1983-84. For several years during that period, when the Government initiated a directed economic policy, assigning priority to a number of social objectives rather than to boosting industrialization, consumption levels remained practically stationary as the net result of a fall in industrial consumption offset by growth of domestic,

administrative and social consumption, the latter being obtained in part by electrification of new centers. Thus, the five localities that were electrified in 1982 (Ouagadougou, Bobo Dioulasso, Koudougou, Ouahigouya and Banfora) were joined by seven new centers in 1983 and another six in 1986. Growth recovered after 1986: over the period 1986-90, the growth rate for the country as a whole averaged 9 percent (see Annex II, table 1).

2.05 The structure of consumption varies widely from one center to another. The two major cities, Ouagadougou and Bobo Dioulasso, contain all categories of consumers, though share of industrial consumption is larger in Bobo Dioulasso. In some secondary centers, certain important industries may account for the bulk of consumption, as for example at Koudougou, where the Faso-Fani textile factory consumes 80 percent of all the electricity sold.

2.06 Most industrial units located in secondary centers, however, possess their own generating facilities and buy little power from the public network. Tables 2 and 3 depict the development of consumption for the two (nascent) electric power systems: first, the central system, comprising Ouagadougou and Koudougou, interconnected in 1991, and also the satellite localities; and second, the western system, comprising Bobo Dioulasso and Banfora (in process of interconnection). It is noted that during the recent period, 1986-90, low-voltage consumption generally grew faster than medium-voltage consumption.

TABLE 6

Development of Sales Structure, 1986-1990

		1986		1990		Growth Rate (%/year)
		GWh	%	GWh	%	
Central System (Ouaga., Koudougou) (See table 2)	MV	46 575	57.5	55 609	50.3	4.53
	LV	34 382	42.5	54 872	49.7	12.40
	Total	80 957	100.0	110 481	100.0	8.08
Westernstem (Bobo, Banfora (See table 3)	MV	18 625	61.2	23 906	60.9	6.44
	LV	11 792	38.8	15 320	39.1	6.76
	Total	30 417	100.0	39 226	100.0	6.57
Isolated Centers (See table 4)	MV	1 751	34.6	3 235	31.5	16.6
	LV	3 308	65.4	7 049	68.5	20.8
	Total	5 059	100.0	10 284	100.0	19.4
Total, SONABEL	MV	66 951	57.5	87 750	51.7	5.4
	LV	49 482	42.5	77 241	48.3	11.8
	Total	116 433	100.0	159 991	100.0	8.3

2.07 The structural change in electricity sales noted over the last five-year period is not explained by structural modification of the Burkina economy but rather by the effect of the directed activities of electrification of new localities and of new neighborhoods in the major cities. These activities, backed by commercial campaigns aimed especially at promoting connections to the new networks, conducted by SONABEL with some degree of success, are in fact addressed mainly to the small LV subscriber group (households, businesses, government). It can therefore be considered that the growth of LV consumption reflects to some degree the stimulatory effect of SONABEL's marketing campaign while the growth of MV consumption reflects more passively the general evolution of economic activity.

2.08 The characteristics of daily and seasonal demand fluctuations differ appreciably from one center to another, reflecting each center's consumption structure. At Ouagadougou, office air-conditioning is a large electricity user: it accounts for nearly 45 percent of peak consumption and its share in the formation of demand peaks widely exceeds that of lighting. At Bobo Dioulasso, air-conditioning consumption represents only 15-20

percent of peak demand, and is in better balance with the other types of consumption; this produces a load curve with three equally important daily peaks during the hot months and consequently a high peak capacity utilization factor. At Koudougou, the demand fluctuations chiefly reflect the work program of the Faso-Fani textile factory. The latter normally operates continuously for 11 months of the year and shuts down for a month in July or August. In the small secondary centers, lighting generally tends to be the major consumption category, with a characteristic peak in the evening and a fairly moderate seasonal variation. This diversity of consumption structures between the various centers will narrow in step with their interconnection in increasingly extensive regional networks. Detailed study of these aspects continues to be important, however, for dimensioning the networks and generating facilities. Moreover, concerted action needs to be mounted in order to gain better control over electricity use by consumers and boost its efficiency for the various use categories, particularly lighting and air conditioning. Note that the Government has enacted administrative regulations limiting air-conditioning periods in public buildings; these measures need to be refined by means of specialized technical studies and supplemented by improvement to the air conditioning plant in question.

Demand forecast

2.09 Despite the rapid growth of electricity consumption, sustained over more than two decades, per capita consumption remains low. In 1991 it was only 20 kWh/year. This national average is obviously not very meaningful since the great majority of the population have no access to electricity service at all. In 1992 the electrified cities together accounted for about 15.5 percent of the total population of the country, and only 20-30 percent of their households were connected to the electricity network. This means that only about 4 percent of the population of Burkina Faso currently have access to electricity service. This figure points to a substantial latent demand and implicitly indicates the advantage of effectively capturing it by continuing the process of electrifying new neighborhoods and localities and also through appropriate methods of promoting connections within the new networks. Under these circumstances, the future evolution of electricity demand depends not only on the estimated general trend of economic activity and the purchasing power of the population but also to some degree on the development goals set by the Government in light of the financial resources at its disposal.

2.10 Demand forecasts have been produced by a number of studies during the last few years. These include:

- the study for the Burkina Faso Electrification Master Plan carried out by the consultants Coyne & Bellier (France) in 1987;
- the tariff study conducted by Electricité de France in 1989;
- the study of the Ghana-Burkina Faso interconnection done by Tractebel (Belgium) in 1991.

Table 7 and figure 6 show the projections made by these studies and the recent (1992) projections by SONABEL. The table shows that the projections made in 1987-88 were generally not borne out by the facts since the actual figures for 1990 and 1991 exceeded the maximum levels projected. The recent SONABEL projections seem to be well-judged, being based on more fruitful data than the previous studies.

2.11 Table 7 shows a breakdown of the projections used for the analyses contained in the present report. It is necessary to set quantified goals with respect to maximum demand, minimum demand and the apparently most likely level between these two extremes, each of these levels having a specific function in the planning studies. For the purposes of this presentation we have used the three consumption subsets already referred to: the central system, the western system and the isolated centers. Some of the centers now isolated will obviously be linked in time to the central or western system; the pace of interconnection could therefore affect the limits of sharing among the three subsets. Total consumption, however, will depend primarily on first the country's general economic development and second the expansion of the distribution networks. The presentation of figures below in no way implies that the projections problem can be regarded as resolved. Studies designed to update the projections will have to be performed at regular intervals by SONABEL staff.

TABLE 7

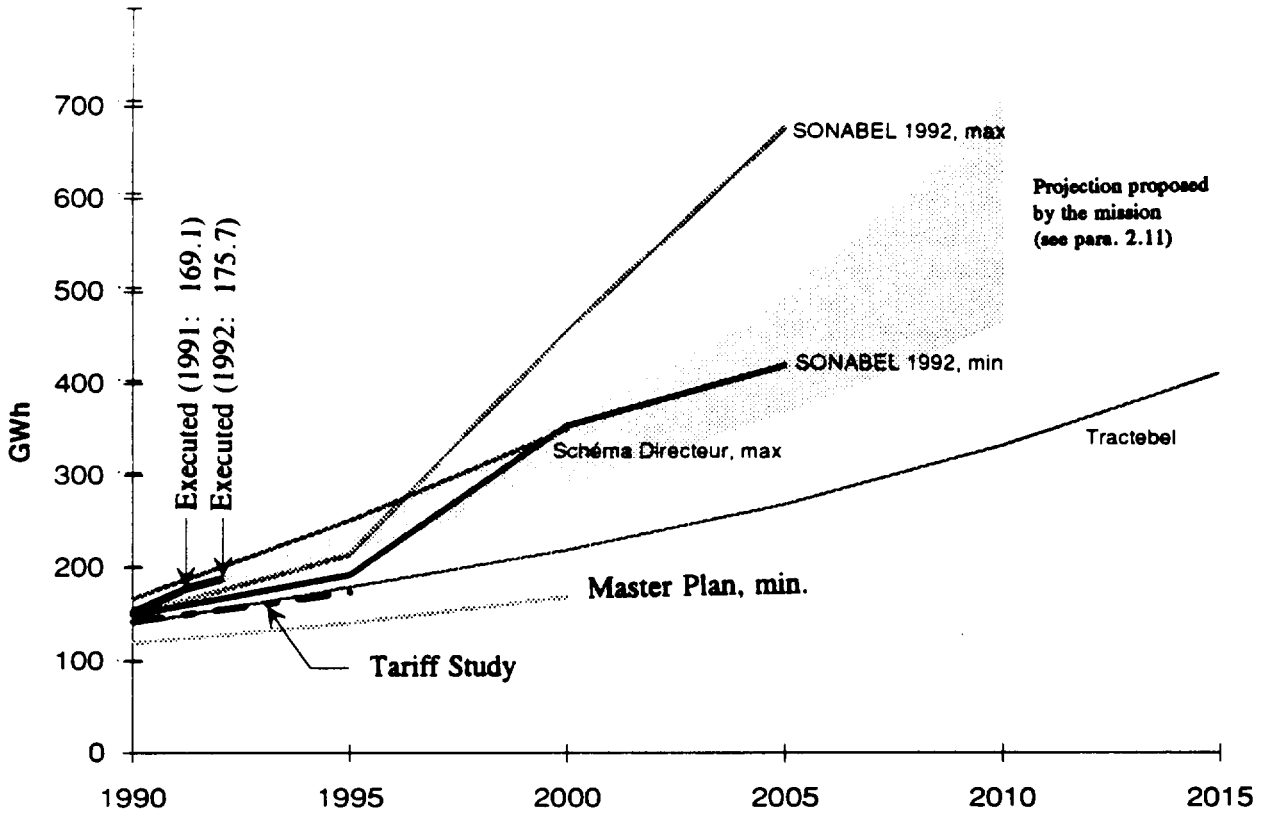
Consumption Projections Used
(gwe)

		1990 (Actual)	1995	2000	2005	2010
Central system	max	110.5	162	228	305	408
	min		148	193	241	300
Western system	max	39.2	60	86	115	154
	min		50	64	80	100
Isolated centers	max	10.3	23	46	81	143
	min		18	29	43	63
Total, SONABEL	max	160.0	245	360	501	705
	min		216	286	364	463
Growth Rate (% / year)			1990-95	1995-2000	2000-2010	
Central system	max		8.0	7.0	6.0	
	min		6.0	5.5	4.5	
Western system	max		9.0	7.5	6.0	
	min		5.0	5.0	4.5	
Isolated centers	max		18.0	15.0	12.0	
	min		12.0	10.0	8.0	

N.B. Date of the study: September 1992.

FIGURE 6

Demand Projection (SONABEL Total)



III. SONABEL

A. Legal Status and Tax Treatment

3.01 Although the *Société Nationale d'Electricité du Burkina* (abbreviated SONABEL) has existed under this name only since 1984, its current legal status was established in 1976. Until then the company (which was then called VOLTELEC) was a limited liability company which held a number of concessions. In 1976 it was accorded the status of a public establishment, industrial and commercial category (Decree no. 76-344/PRES/MTP/URB) and also the exclusive right to generate, transmit and distribute electric power, as principal activity, throughout the national territory (Ordonnance 76-021/PRES/MTP/URB). The company's capital is currently CFAF 1,387,628,180 and is held entirely by the Government.

Brief history

3.02 The beginnings of public electricity distribution in Burkina Faso date back to 1954, when the company ENERGIE AOF (*Energie de l'Afrique Occidentale Française*), a mixed-capital company based at Dakar, began to carry out this activity in the cities of Ouagadougou and Bobo Dioulasso under the managership system. In 1956 the company also obtained a management contract for water distribution in these two cities. In 1957 the managership system was replaced by the concession system in the case of electricity generation and distribution only, while water distribution remained under management.

3.03 Following independence in 1960 the Company, which was engaged in similar activities in other West African countries, was converted into a multinational mixed-capital company, *Société Africaine d'Electricité* (SAFELEC), with a capital of CFAF 150 million, distributed among Electricité de France, the Republics of Upper Volta, Mauritiania and Niger, the Caisse Centrale de Coopération Economique (CCCE) and various private shareholders.

3.04 Desiring to control essential economic activities within its territory, the Republic of Upper Volta decided to set up a national agency responsible for the public electricity generation and distribution service. Thus began the nationalization process which was to culminate in the transfer of ownership of SAFELEC to the Upper Volta Government. As the first step in this process, in 1968 SAFELEC's activities in Upper Volta were brought together in a limited liability company established under Upper Volta law, *Société Voltaïque d'Electricité* (VOLTELEC), whose capital continued to be held by SAFELEC's shareholders. The second step was taken in October 1969, when the Government bought back all the shares in VOLTELEC.

3.05 In 1970, following the creation of the National Water Company (*Société Nationale des Eaux--SNE*) by the Upper Volta authorities, VOLTELEC transferred its water distribution operations to SNE and retained only the electric power operations, under the concession system at Ouagadougou and Bobo Dioulasso and under the managership system at Ouahigouya. Between 1971 and 1976 the cities of Koudougou and Banfora were added to VOLTELEC's concession and the managership system was replaced by the concession system for all the cities served by VOLTELEC.

3.06 Since September 1976 the Company has been a public establishment (industrial and commercial category)[5] with the exclusive right to generate, transmit and distribute electric power, as principal activity, throughout the national territory. This "exclusivity" is generally understood in Burkina Faso to mean a monopoly even though, legally, it can be interpreted differently. However, so far as electricity generation is concerned, in practice the "monopoly" is ineffective.

State jurisdiction

3.07 The regulations governing public industrial and commercial establishments in effect in Burkina Faso[6] prescribe the *modus operandi* of these agencies and in particular the procdures for their supervision by the Government. Such an establishment, "which, in a habitual manner, perform business acts and operate in conformity with the laws and usages of trade and business" is subject to government tutelle of three kinds:

- **technical supervision,** exercised by the ministry responsible for the sector concerned, in this case the Ministry of Energy and Mining, within which a post has been provided of Delegated Minister of Mining and Energy;

- **financial supervision,** exercised by the Ministry of Finance and Planning;

- **management supervision,** exercised by the Ministry of Industry, Trade and Mining.

3.08 The supervisory agencies perform this function by nominating the members of the Board of Directors and the General Manager (Director General), who are appointed by the Council of Ministers, and permanently monitoring the work of the Board of Directors. They can oppose any decision of the Board of Directors that is deemed to be inconsistent with government policy.

3.09 SONABEL's Board of Directors comprises seven members of whom four represent the supervisory ministries and the Water Ministry and three represent the workers' unions. In principle the Board can have up to 12 members, half of them representing the Government and the other half delegates of the workers' unions. The Board of Directors elects its Chairman from among the directors representing the technical tutelle agency, for a term of three years, which is renewable. The Chairman of the Board of Directors is accountable to the Council of Ministers, which may revoke his appointment and remove him from the office of director, for example if the mandatory annual meeting does not take place. The Board of Directors can propose to the Council of Ministers, through the Minister with technical jurisdiction, that the appointment of the General Manager be revoked if the latter is in default or has committed a serious management error.

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[5] Decree no. 76/344/PRES/MTP/URB.

[6] - Order (Ordonnance) no. 84-058/CNR/PRES of August 15, 1984 laying down general regulations governing the state public establishments.
- Decree no. 84-304/CNR/PRES/MF/MCSE of August 15, 1984 defining the general statute of the industrial and commercial public establishments.

3.10 The chief observation prompted by the current institutional structure is that it does not further the aim of reducing the cost of electricity. It is in fact cumbersome and composed largely of government agencies or representatives who are not necessarily cut out to manage economically a complex technical system like the electricity sector. The large number of workers' union representatives on the Board of Directors could hamper pursuit by the General Manager of a stricter policy designed to control personnel expenditures. That being so, it would be advisable to examine the possibility of opening SONABEL's capital to private participation, making it possible to strengthen the Board of Directors by representatives of national entrepreneurs and possibly also of the donors.

Tax System

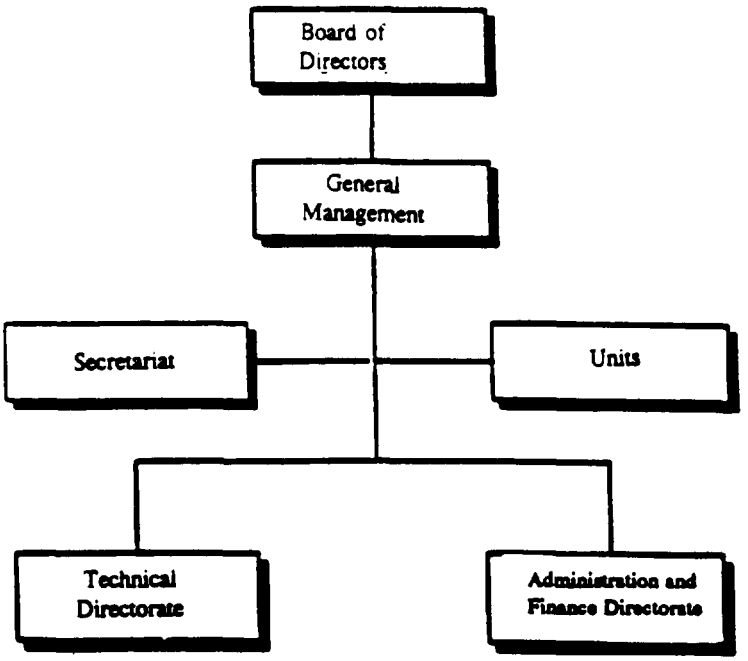
3.11 SONABEL enjoys preferential tax treatment, being exempt from all duties and taxes on the importation of equipment, spare parts and tools and on assembly and maintenance. It is also exempt from all taxes, all entry duties and the specific tax on fuels and lubricants intended for the operation of generating plant. The exemption does not apply to the importation of services or to vehicle fuels. SONABEL is however liable to a number of taxes and duties, notably the IBICA (tax on industrial, commercial and agricultural profits), the IMFPIC (minimum flat-rate tax on industrial and commercial professions), VAT (value added tax), the taxes on the rental value of premises used for professional purposes, and the stamp duties.

B. Internal Organization and Management Structure

3.12 SONABEL's organization has undergone a number of changes during the last few years, including abolition of the post of Assistant General Manager and the creation of two directorates: a Technical Directorate and an Administration and Finance Directorate. The Company's senior official is the General Manager, whose work is supervised by the Board of Directors.

FIGURE 7

Main Organization of SONABEL



3.13 The General Manager is assisted by four consultative units composed of senior management staff:

- The *General Economic Programs and Projections Unit* (CPPEG), which provides advisory assistance on budgets and investment programs.
- The *Internal Control Unit*, which monitors all activities of the various services and verifies compliance with the internal operating regulations.
- The *Management Control Unit*, whose activities include supervision subscribers and installations; its main purpose is to supervise budget execution.
- The *Legal Affairs Unit*, which among other functions organizes the Company's calls for bids.

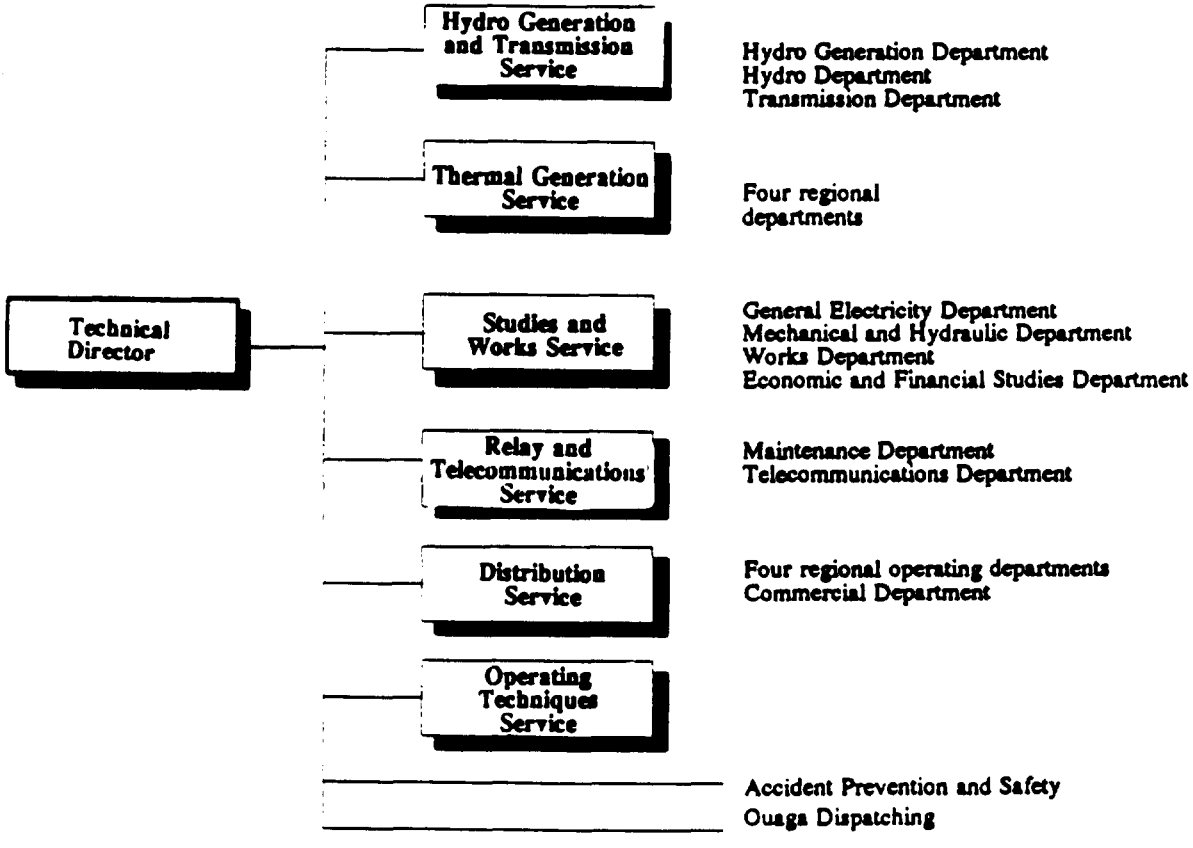
A new unit, with the status of a service, has been added to those answerable directly to the General Manager: the Organization and Methods Service (see figure 12, Organization Chart of SONABEL).

3.14 Management of SONABEL is organized around a simple and clear structure comprising two directorates: the Technical Directorate and the Administration and Finance Directorate.

3.15 The Technical Director is responsible for (a) day-to-day operations and subscriber management, and (b) development-related activities. His Directorate comprises six divisions, known as "services," each divided into several departments. Two departments are under the Technical Director's direct authority. These are the Accident Prevention and Safety Department, which is responsible for laying down and supervising compliance with regulations in these areas, and the Dispatching Department, responsible for distributing power generation among the Ouagadougou thermal power stations and the Kompienga hydroelectric station.

FIGURE 8

Organization Chart of the Technical Directorate



3.16 The Hydroelectric Generation and Transmission Service is responsible for operating the Kompienga hydroelectric power station and the 132-kV transmission lines between Kompienga and Ouagadougou. It will similarly be given responsibility for operating the new Bagré Hydroelectric Plant as soon as it comes on stream and is handed over by the Bagré Project Authority.

3.17 The Thermal Generation Service is responsible for operating the thermal generating plants in Ouagadougou, Bobo Dioulasso and the secondary centers. The Service organizes the procurement of fuel oil, DDO, gas oil and lubricants for operation of the diesel plants. It is also responsible for all maintenance work both in the two large centers of Ouagadougou and Bobo Dioulasso and in the secondary centers. The secondary centers normally have a mechanic who is responsible to the chief of the center but is answerable also to the Thermal Generation Service with respect to technical questions. For that purpose the Service has an action team for each group of secondary centers which executes scheduled overhauls and act in cases of serious breakdown.

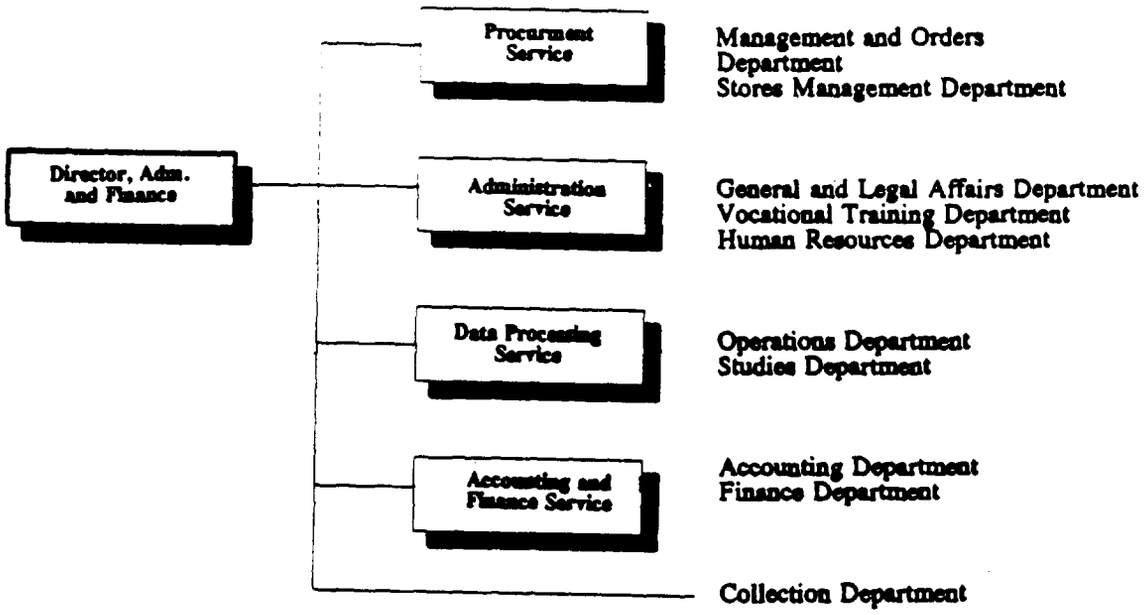
3.18 The Studies and Works Service is SONABEL's engineering unit. It is responsible for planning future activities and studying and implementing new transmission and distribution projects. It also provides liaison with the consulting engineers used by SONABEL for studies and projects. The Service recently acquired a PC-based information system for the performance of technical analyses and calculations.

3.19 The Relay and Telecommunications Service is responsible for operating and maintaining the auxiliary equipment of the SONABEL plant. It is called on in cases of problems of repair and adjustment of the regulating systems. It is also responsible for maintaining SONABEL's measuring and metering equipment. Its responsibilities also include the communication systems that link the SONABEL centers with the headquarters office and equipping the field personnel with mobile radios.

3.20 The Distribution Service is responsible for customer relations and sale of power to consumers. It is also responsible for establishing necessary extensions of the LV network for consumer connection and for LV network planning. The secondary centers are under the hierarchical jurisdiction of the Distribution Service, which supervises them through the four regional department heads. The Service is responsible for active marketing of electric power, notably in the newly electrified areas of the secondary centers and the suburbs of Ouagadougou, with the aim of increasing the number of consumers connected to the network. This work yields only limited results, however, owing to the low resources available to SONABEL for expansion of the distribution networks, and it appears that electricity demand in the large centers is still not being fully met.

FIGURE 9

Organization Chart of the Administration and Finance Directorate



3.21 The Director, Administration and Finance is in charge of four divisions or "services": Procurement, Administration, Data Processing, and Accounting and Finance.

3.22 The Procurement Service is responsible for ordering spare parts and managing SONABEL's central stores. In the case of calls for bids the Service works in liaison with the Legal Affairs Unit with respect to commercial terms and with the Studies and Works Unit with respect to technical definitions.

3.23 The Production Service's stores are located in the generating stations and belong to the power station. To distinguish among the various suppliers, the power stations possess several different stocks which are separated physically, each with a spare parts stockroom. While this system provides great simplicity of design and good accessibility for operational users, it does not allow coordination among power stations with identical equipment. The authorities should consider improving the system by introducing central stock management. The stock of distribution materials and equipment is kept in a central store in Ouagadougou, located at the Ouaga I power station. Note that SONABEL has achieved a high degree of standardization of equipment in this field.

3.24 The Administration Service is responsible in particular for personnel management, recruitment and training. It is also responsible for SONABEL's automobile fleet and for administrative questions. It is currently starting up a Personnel and Training Master Plan in cooperation with an external consultant.

3.25 The Data Processing Service is responsible for introducing data processing methods into SONABEL's administrative organization. A general plan (Data Processing Master Plan) has been drawn up with the help of a consulting company. The introduction and increasing use of data processing systems in SONABEL's organization conform to the guidelines of the master plan. A number of working groups have been set up to implement the data processing systems. Each group is in charge of a data processing subsection: financial management, customer management, and inventory management. The Service is responsible for setting the specifications of the data processing equipment and software. The SONABEL plan includes equipping Department 1 at Ouagadougou with a UNIX-based central data processing system in 1992, Department 2 at Bobo Dioulasso with an identical system in 1993 and the other departments of the centers during the period 1993-95. It is also planned to network the various centers.

3.26 The Accounting and Finance Service is responsible for accounting and financial matters except for borrowing debt management. Note that no system of independent auditing of SONABEL's accounts and financial statements has so far been instituted.

Organization of the secondary centers

3.27 The two regional systems of Ouagadougou and Bobo Dioulasso currently account for about 95 percent of electric power consumption in Burkina Faso. The remaining 5 percent is consumed in the secondary centers, supplied by SONABEL generally by means of a diesel-fired thermal power station and a distribution network. A total of 11 secondary centers are currently supplied in this way, and the Master Plan proposes that 9 secondary centers shall receive consideration.

3.28 The secondary centers are organized under the authority of the Distribution Service. They are grouped into four departments by geographic zone. Each center has a staff ranging from 5 to 8, depending on its capacity:

- 1 center chief
- 1 mechanic
- 1 electrician*
- 1 meter reader*
- 1 cashier*
- 1 laborer
- 1 guard

* These functions are sometimes performed by a single person.

The Center Chief is answerable to the Department Head and the latter to the Chief of the Distribution Service, based at Ouagadougou. Maintenance of the power station and the distribution network is performed locally. In the case of large overhauls or breakdowns a mobile team is sent out from headquarters in Ouagadougou. Overhauls are programmed in coordination with the Thermal Generation Service, and a mobile unit of this service may be needed during the overhaul periods.

3.29 The internal electrical installations are carried out by local craftsmen and connections by SONABEL staff. SONABEL staff check the installations and where necessary refuse connection to the network if their quality is not up to standard. Illegal connections are not currently a major problem in Burkina Faso. A few cases have however been reported, mainly at Ouagadougou. The Management Control Unit is responsible for detecting cheating; it uses a team of six inspectors for this purpose, five of whom are located in Ouagadougou.

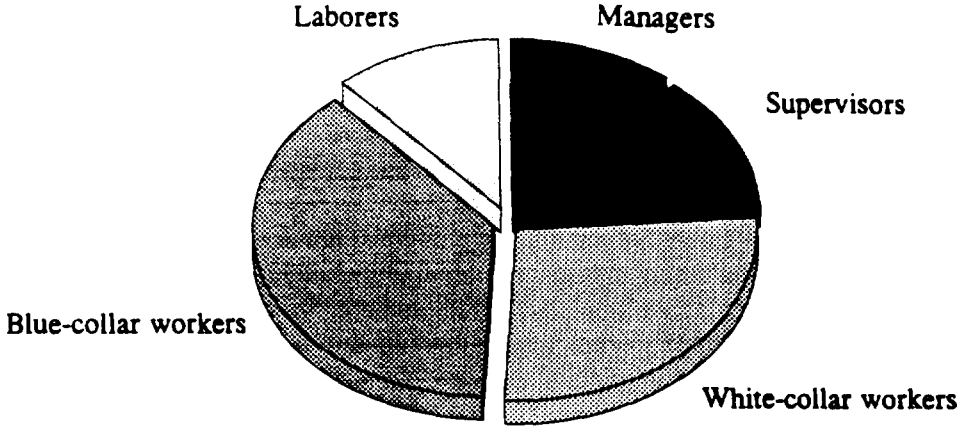
3.30 The SONABEL instruction and training center provides part of the personnel training, generally that for SONABEL white-collar and blue-collar staff working in the network facilities. SONABEL does not, however, provide training for skilled electricians who are not its employees. The idea should be considered of SONABEL helping with the training of craftsmen electricians as part of the process of subcontracting the tasks of maintaining and developing distribution networks and connections to the private sector.

C. Labor Force and Job Instruction/Training

3.31 In 1992 SONABEL had a total labor force of 1,244 distributed among the following categories: **management staff** (higher education graduates), **supervisory staff** (technicians and senior technicians), and **operatives**, the latter divided into three sub-categories: clerical staff, skilled workers and unskilled workers. Figure 10 depicts the present distribution of the staff and table 13 its historical development.

FIGURE 10

Distrubution of Labor Force by Wage Category, 1991

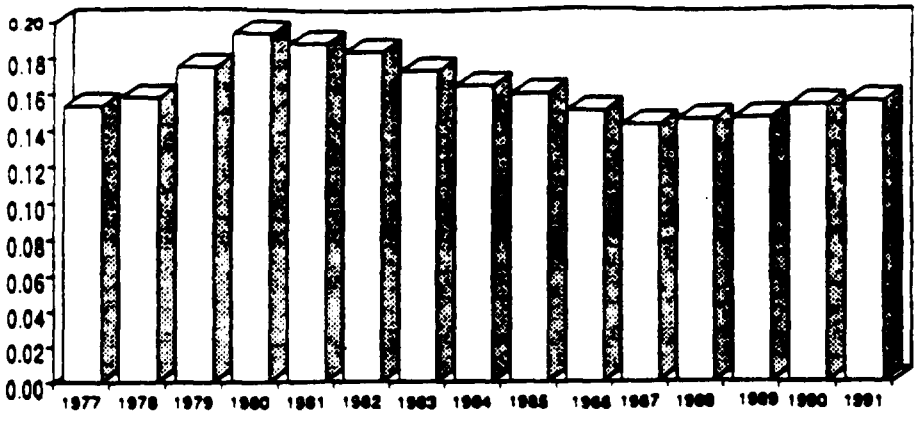


3.32 Analysis of the development of the labor force shows first of all that SONABEL has not achieved the productivity gains to be expected in an electricity company that has posted average annual growth of over 9 percent for the past two decades. The labor force has in fact grown faster than the volume of energy generated and distributed, with the result that total gross output per employee fell from 0.194 GWh in 1980 to 0.155 GWh in 1991. In comparison, the output figures in the neighboring country of Ghana range from 0.16 GWh in the northern part of the country (Northern Electricity Department) to 0.5 GWh in the ECG (Electricity Corporation of Ghana) distribution network. In developed countries the figure is 5-6 GWh/employee. This latter figure is of course mentioned only for information since the electricity structures of the developed countries cannot be compared with those of Burkina Faso, where LV consumption is relatively high (about 50 percent of total consumption), with dispersed subscribers, many of whom have low annual consumption levels.

FIGURE 11

SONABEL: Labor Force Productivity

GWh/employee



3.33 Concerning the structure of the labor force, a substantial increase is observable in 1988 in the number of management staff, which tripled in three years. The share of management staff in the Company's total labor force, which had been about 4-5 percent, rose to 11.2 percent in 1991. At the same time the proportion of supervisory staff declined, from 17 to 13 percent. Currently, there are about the same number of management as of supervisory staff, whereas before 1988 the ratio of supervisory to management staff was 3 or 4 to 1. The decline in the number of supervisors and the rise in the number of managers are due to redefinition of employee categories under the new personnel statute that entered into effect in 1989. The existing three categories were replaced by four categories and in this process one of the supervisory grades was transferred to the management category. To this must be added the effect of the arrival of young managers who have graduated from higher education; while this to some extent reflects modernization of the Company's activities, it also poses the problem of preparing young managers to assume certain responsibilities previously exercised by supervisory staff. These young managers could be greatly helped by providing them with supplementary training in the practical aspects of operation of the enterprise and the pertinent technical regulations.

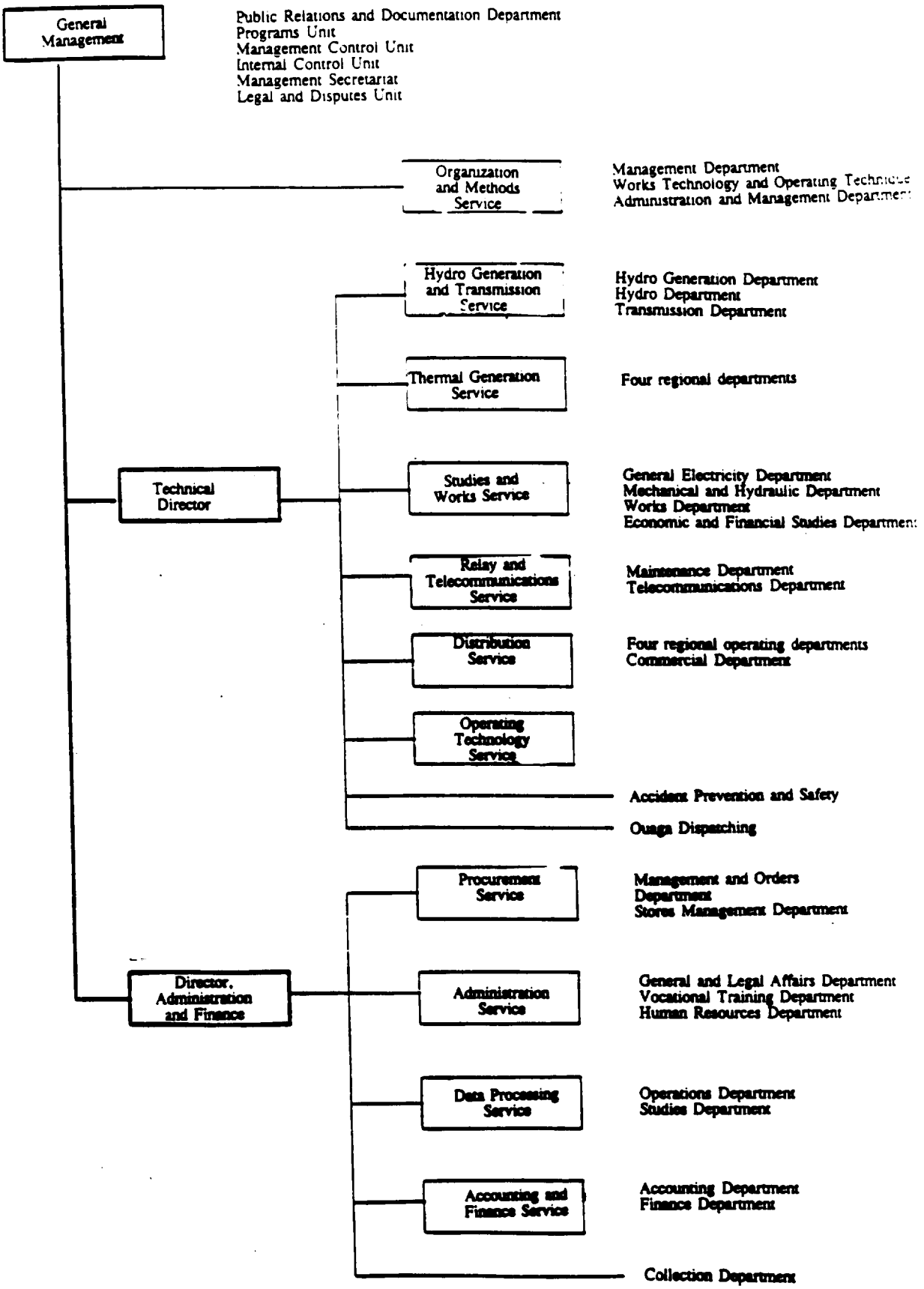
3.34 In some activities the staff are insufficiently experienced. SONABEL depends greatly on the assistance of engineering consultants for network planning and new facilities engineering, though it is able to carry out increasingly complex engineering works using its own staff. It now possesses young managers with sound basic training and their specialized skills could be perfected by involving them more in the studies done for SONABEL by consulting engineers.

3.35 SONABEL is currently preparing a personnel development plan with the help of external consultants. The general plan will indicate the new skills considered necessary for development of the 132-kV transmission network or ofssible 220-kV interconnections with Côte d'Ivoire and later with Ghana. SONABEL's present human resource development strategy is built around the recruitment of graduate engineers. SONABEL is using the ESIE (*Ecole Supérieure d'Ingénieurs Electriciens*) in Abidjan for supplemental training of engineers; 11 SONABEL engineers have received this training so far. SONABEL's needs in terms of post-training specialization of human resources are difficult to define; for that reason SONABEL relies mainly on external education centers for that specialized training. In the years to come SONABEL envisages moving part of its skilled labor force from thermal generation to the transmission networks and hydro generation in order to deploy its staff more efficiently.

3.36 SONABEL possesses its own training center for the technical instruction of skilled and unskilled workers. The staff engaged in this category normally possess basic training as professional worker through a 12-month instruction program. The training center has 7 permanent instructors and 9-10 instructors recruited from SONABEL personnel. The engineers recruited from the educational establishments (ESIE and the higher schools of technology at Dakar or Bamako) normally follow a 12-month instruction program as trainees in the various departments of SONABEL, including 3 successive weeks in the Vocational Training Center. The center possess an adequate selection of equipment, specialized in the field of electricity supply, which has undergone donor-financed improvements. The student accommodation center can accommodate up to 60 trainees in the resident courses and the trainees acquire practical experience by means of small projects executed on the SONABEL network.

FIGURE 12

SONABEL: Organization Chart



IV. ELECTRICITY GENERATING, TRANSMISSION AND DISTRIBUTION SYSTEM

A. Objectives and Strategy

4.01 The Government's national electric power supply policy is based on the Burkina Electrification Master Plan for the period 1986-2000. This important document, which the Government adopted in 1987, defines the broad guidelines for electrification of the country. The main strategic objectives are:

- to supply electricity, at lowest cost, to all parts of the country;
- to bolster the development of the modern sector of the national economy.

These strategic objectives of the Government are consistent with the pursuit of economic development. It should be noted however that the lowest-cost constraint imposes the need for great prudence in considering certain projects, particularly large hydroelectric projects.

4.02 The main lines of action set forth in the Master Plan, which are of course interdependent, are as follows:

(a) Construction of two regional generating/distribution systems

- The Central System (Ouagadougou-Koudougou), supplied by thermal plants at Ouagadougou, the Kompienga and Bagré hydroelectric stations, and later interconnection with Ghana.
- The Western System (Bobo Dioulasso-Banfora), supplied by the Bobo Dioulasso and Banfora thermal plants, the Niofila and Tourni mini hydroelectric stations, and later interconnection with Côte d'Ivoire.

The creation of the regional systems will make it possible to install large generating units at Ouagadougou and Bobo Dioulasso, using less expensive fuels. The two systems could be interconnected later, for example if the Noumbiel hydroelectric dam project is carried out. The secondary centers will be connected to the two primary centers in stages.

(b) Construction of interconnections with neighboring countries

This will allow Burkina Faso to import energy from these two countries, which have surplus hydro capacity.

(c) Reduction of fuel costs, by:

- reducing specific fuel consumptions through rational operation of the existing generating plant, better location of the sets and control of auxiliary plant consumption;

- using less expensive fuels, for example fuel oil instead of DDO for equipment that allows this;

- diversifying generating sources by building hydro power stations in addition to thermal plants;

- diversifying fuel procurement sources in order to obtain the best purchase terms on the world market.

(d) Electrification of new centers and extension of the networks in order to improve coverage of the country and reach the largest possible number of consumers.

4.03 The electricity development projects implementing this government policy are prepared and discussed within SONABEL and then at the level of the supervisory ministry (the Ministry of Industry, Trade and Mining) and finally discussed and adopted at working meetings of the National Planning Council. Execution of the projects is dovetailed with the five-year plans (the first plan covers the period 1986-90 and the second 1991-95).

B. Electrification of the Country

4.04 The two regional networks, Ouagadougou and Bobo Dioulasso, currently account for about 95 percent of Burkina Faso's electric power consumption. Ouagadougou supplies Koudougou and Zinaire via an interconnection, and the small center of Réo is included since it is connected to Koudougou. A 33-kV interconnection between Bobo Dioulasso and Banfora is under construction (1992) and SONABEL has the 33-kV extensions that will reach Orodara and Niangoloko in the planning stage. This will constitute the western regional network, with Bobo Dioulasso as its primary center. The remaining 5 percent of electric power consumption is accounted for by the secondary centers, supplied by SONABEL, generally by means of a diesel plant and a distribution network. A total of 11 secondary centers are currently being supplied in this way, and the Master Plan proposes a further 9 secondary centers for consideration.

4.05 The Master Plan calls for phased interconnection between the secondary centers and the regional centers in order to take advantage of the low generating costs of the large diesel-fired units using heavy fuel oil. A calculation model of the feasibility of interconnection was prepared as part of the Master Plan study. Application of this model has shown that in most cases the diesel units are still the best way to supply electricity to the secondary centers until the need reaches a level that justifies interconnection to the regional network. This conclusion seems to be entirely reasonable. Note however that in the event that interconnection of a secondary center to the regional network becomes justified, this involves taking the secondary center's diesel power plant out of service. SONABEL has recently carried out studies of rural electrification possibilities, including the feasibility of electrifying the secondary centers of Nouna, Diebougou and Kongoussi.

Impact of rural electrification

4.06 Rural electrification has had only a limited impact on the development of the electrified secondary centers. It is on the social side that electrification has had the most

positive impact, since households account for the bulk of demand (lighting and domestic appliances). In industry, business and crafts, electrification has evidently had only a very limited impact on the development of new activities. It can be concluded that, for the moment, rural electrification cannot be regarded as a catalyst of local development. It must be regarded as an infrastructure item that supports normal, existing industrial and business activities and in particular improves the level of living and the conditions for social progress.

4.07 Consumption by SONABEL's " 3-A Tariff" subscribers averages 300-400 kWh a year, equivalent to monthly expenditure of CFAF 2,500-3,200. Since electrification primarily replaces lighting kerosene and radio batteries, the cost can be calculated as follows (see ref. source 25). A household consumes on average 5 liters of kerosene at CFAF 150/liter and 6 batteries a week at CFAF 120 each. This gives monthly expenditure of CFAF 3,600. In view of the large number of consumers connected under the "3-Amps" tariff system, this calculation can be regarded as a realistic indication of the consumer's willingness to pay. This topic deserves closer attention in order to ascertain the number of "3-Amp" subscribers who could have a higher consumption level by moving to a higher subscribed capacity category. The economic efficiency of the networks in the rural regions may depend greatly on the rates arrangements applied, since although in those regions electricity is clearly not going to replace the use of firewood for cooking, it can have uses other than lighting and air conditioning.

4.08 Electrification of secondary centers in Burkina Faso has helped to improve living conditions. It is not yet known, however, to what extent electrification of secondary centers can halt or slow rural migration to Ouagadougou and Bobo Dioulasso. At present only a limited number of potential consumers are connected to the network, and one of SONABEL's tasks continues to be to improve the turnover of the electrified secondary centers by raising the percentage of consumers connected directly to the existing networks. SONABEL's experience shows that electrification of secondary centers generally posts losses during the initial years of operation. It takes 8-10 years of operation for the number of consumers to rise to a break-even level between electricity sales receipts and production cost, including generating equipment and network amortization.

Alternative in the rural electrification field

4.09 At present SONABEL is the only legal supplier/generator of electric power in Burkina Faso. It has no legal obligation, however, to provide electricity supply in regions where electrification is not economically viable. Possibilities exist of supply from other sources, such as private generators. An example is afforded by electrification of Poura and in the future of Fara from the electro-generating sets of the mine near Poura. In this case SONABEL buys the electricity from the self-producers and distributes it to its customers. A similar possibility exists at Houndé, where SOFITEX operates a cotton mill which possesses electricity generation reserves throughout the year, including during the six-month cotton season. At Houndé SOFITEX already assumes responsibility for a very small number of consumers to whom it offers electricity free of charge in order not to infringe on SONABEL's monopoly.

4.10 One possible means of future development of rural electrification could be to open it up to private enterprise, provided distribution facilities can be built to satisfactory standards, even if not necessary identical to those applied by SONABEL. Networks of this kind would have to be financed through the price charged for the electricity; this would allow

the development authorities to apply a tariff based on local generation plus amortization costs, a tariff that is not necessarily the same as SONABEL's general and national tariff system. Electrification systems of this kind can be set up under a cooperative scheme based on the shared interests of a group of villages. With these more flexible types of organization it would also be possible to encourage greater use of renewable energy sources, for example for facilities of very low capacity (a few tens of kW), based on solar energy, wind energy and small hydro falls. SONABEL's involvement in these operations could be limited to an advisor or subcontractor role for very specific aspects defined contractually in financial terms. Such operations need to be soundly prepared, however, in order to ensure the necessary technical capacity and the permanent presence of the local management entity. Account will also have to be taken, by way of comparison, of the service that SONABEL could offer if were accorded the same treatment with respect to tariffs (on a contractual basis).

C. Existing Supply Facilities

Thermal power stations

4.11 The main electricity generating sources are diesel sets, fired by DDO fuel or heavy fuel oil. The Kompienga hydroelectric plant contributes about 8 percent of the total power generated in 1992. Its share will rise to 15 percent when Lake Kompienga is filled. Even with the new Bagré power station, thermal generation will continue however to form the base of electricity generation by SONABEL.

4.12 The total installed capacity of the thermal sets is about 75 MW, distributed among the two large centers and the secondary centers. The characteristics of all the sets are depicted in Annex II, table 7.

TABLE 8

SONABEL Power Stations
(December 1992)

	Installed Capacity (MW)	Peak Capacity (MW)	Ratio P_iP_p	Marginal Prodn. Cost (CFAF/kWh)
Central System	64.9	34.2	1.90	
• Thermal	50.9			26.02
• Hydro	14.0			
Western System (thermal)	16.4	9.6	1.71	29.24
Isolated Centers (thermal)	7.7	4.3	1.79	39.45
TOTAL	89.0	48.1	1.85	

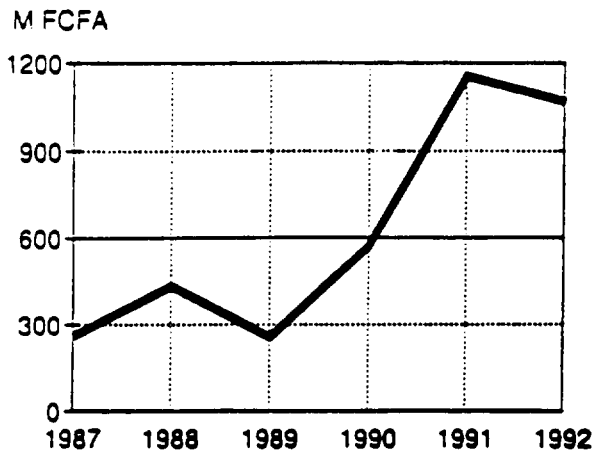
The total installed capacity of 89 MW is adequate to meet peak demand and even leave an incremental demand margin. Note however that the maximum available capacities of many aged sets, notably at Ouagadougou and Bobo Dioulasso, are well below their installed capacities, with the result that the actual margin is just adequate but not excessive. In the case of the central system, two of the Ouaga II power station sets were rehabilitated recently, and this, together with start-up of the hydro plants, allows some breathing space before considering the construction of a new Ouaga III power station.

4.13 The generating costs given above are based on the figures for the financial year ended December 1992. These figures suggest the possibility of optimizing the distribution of production between the thermal sets and the hydro station. For that purpose the marginal cost for each set needs to be known. The marginal costs of the thermal sets will have to be determined by means, in particular, of fuel consumption measurements for each set. Marginal cost in hydro generation will be determined taking into consideration the energy value of the water. A study with a view to optimizing management of the generating equipment stock is under way; it will provide SONABEL with a tool by which to improve electric power generating costs.

4.14 The condition of the sets is illustrated by the operating expenditure figures for the years 1986 to 1992 (Annex II, table 10). They show an unusual rise in spare parts expenditure (for power stations), which grew nine-fold in five years. This increase is due to aging of the thermal plant at Ouagadougou and Bobo Dioulasso. It points to the need for detailed inspection of the status of the thermal stock to enable the authorities to draw up an appropriate rehabilitation program and decide on scrapping of sets that are too old or too worn out to be rehabilitated. The sets scrapped need to be disassembled and removed from the site without delay.

FIGURE 13

Spare Parts Expenditure, 1987-91



4.15 Figure 14 depicts the age distribution of the thermal sets. Sets 13 years old or over account for 50 percent of installed capacity, with only about 8 percent in sets aged over 25 years--which is regarded as the normal operating life for a diesel set.

FIGURE 14

SONABEL: Age Distribution of Installed Capacity, 1992

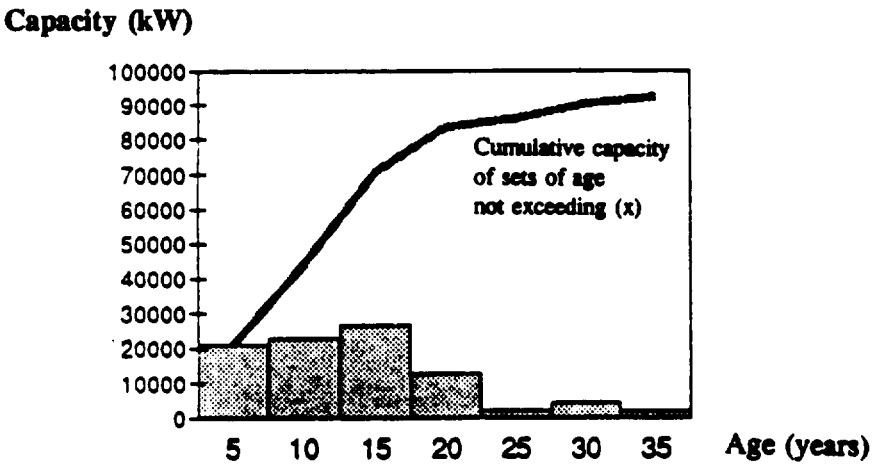


TABLE 9

Diesel Plant of SONABEL Power Stations

Number of Sets and Installed Capacities,
by Age Class and Unit Capacity
(December 1991)

Installation Date	Unit Capacity (kW)				Total
	< 300	301-1000	1001-3000	> 3000	
Up to 1967		3 sets 1560 kW	2 sets 3500 kW		5 sets 5060 kW
1968-72		3 sets 1800 kW	2 sets 2200 kW		5 sets 4000 kW
1973-77		1 set 360 kW	4 sets 6000 kW	1 set 3200 kW	6 sets 9560 kW
1978-82	3 sets 248 kW		3 sets 4060 kW	5 sets 31840 kW	11 sets 36148 kW
1983-87	17 sets 2128 kW				17 sets 2128 kW
1988 +	12 sets 2112 kW	4 sets 1872 kW	2 sets 5400 kW	2 sets 7616 kW	20 sets 17000 kW
TOTAL	32 sets 4488 kW	11 sets 5592 kW	13 sets 21160 kW	8 sets 42656 kW	64 sets 73896 kW

Self-producers

4.16 In addition to the SONABEL power stations, there are entities of all sizes operating generating sets for their own account. The largest of these sets are operated by industrial enterprises, which have installed them either to make up for lack of electricity service in their locality or to take advantage of plant residues or other secondary energy resources produced by their own operations. Some self-producers have electricity surpluses which they are able to sell to SONABEL for distribution.

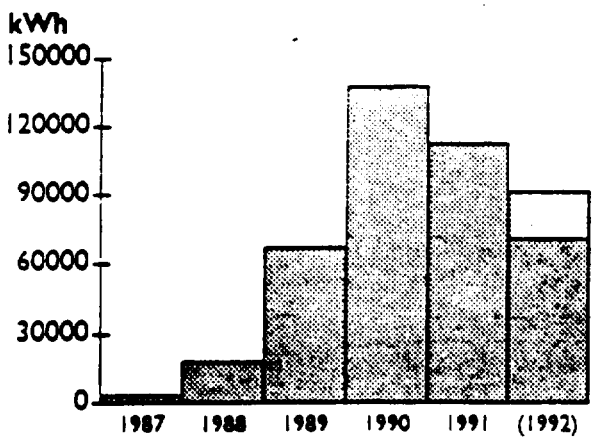
4.17 The *CITEC oil mill* in Bobo Dioulasso possesses a 650-kW steam turbine which generates about 5.3 GWh a year and burns cotton and karite (shea) waste. It runs continuously for 11 months of the year and shuts down in November.

4.18 The company *Grands Moulins du Burkina Faso (GMB)* in Banfora possesses several diesel sets with a total capacity of 1.9 MVA which use DDO fuel and generate about 8 GWh a year.

4.19 The sugar company *Société Sucrière du Comoe (SOSUCO)*, also located in Banfora, is Burkina Faso's largest agro-industrial enterprise. It possesses a total capacity of 2.36 MW, of which 1700 kW is produced by three alternating turbine sets fuelled by bagasse (which is also used to fuel the boilers that produce the technology steam) and 660 kW by three diesel sets using DDO. The alternating turbine sets are used during the harvest season from November to April and the three diesel sets outside the season. The power generated exceeds SOSUCO's own demand, and the surplus is sold to SONABEL, as shown in figure 15. Interconnection between Bobo Dioulasso and Banfora opens up the possibility of establishing economical dispatching between generating sets within the western network.

FIGURE 15

Power Sales by SOSUCO to SONABEL



4.20 The mining company *SOREMIB* in the city of Poura operates four 900-kW diesel sets and one 300-kW diesel set, giving a total installed capacity of 3900 kW. SOREMIB also supplies the Boromo city network and could be interconnected with the city of Fara, which possesses three diesel sets with a total capacity of 80 kVA.

4.21 The *SOFITEX* textile mills in the city of Houndé possess two diesel sets: an 800-kVA set which operates during the season (from October 15 to November 15) and an 80-kVA set used during the off-season. Both sets burn DDO. SOFITEX supplies the local city hall free of charge.

4.22 The large own-account generating enterprises described above generate a total of about 39 GWh a year, including about 12 GWh by burning plant waste. To this must be

added the large number of small generating sets, with unit capacities of between 2 kW and 40 kW, operated by farms, certain public services, small artisan enterprises and many businesses and private individuals. Their total annual output can be estimated at least 20-25 GWh. The electric power produced outside SONABEL is thus of the order of 60-63 GWh a year.

Kompienga hydroelectric power station

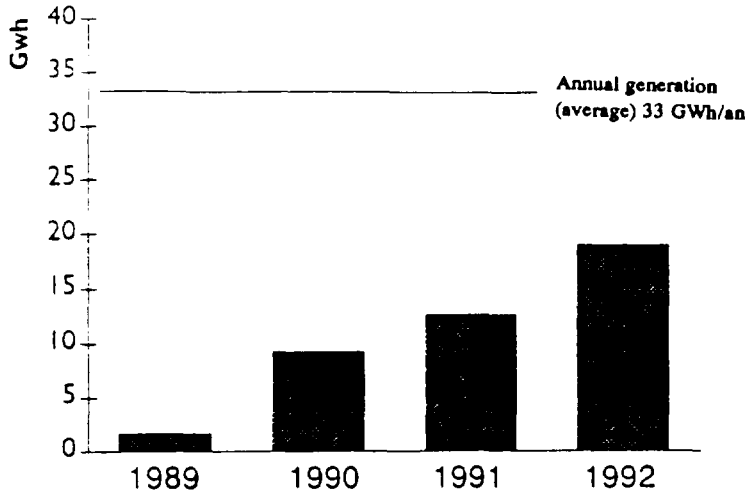
4.23 The Kompienga hydroelectric power station is the first plant of this kind in Burkina Faso. The power station and dam were built during the period 1980-88 with international financing in which a number of donors participated, the largest contribution being made by funds of French origin. The power station is located in southeastern Burkina Faso on a tributary of the Oti River. The site is well chosen from the construction standpoint: the river runs through a wide valley which narrows between two spurs of a low mountain ridge to form an excellent dam site for the dam, about 1,000 m long and 30-35 m wide and composed of natural fill material (rock formations). The power station is equipped with two Kaplan turbines, each with a rated capacity of 7 MW, giving the power station a total capacity of 14 MW. Guaranteed capacity is 5 MW. The Master Plan estimates average electric power generation at 48.3 GWh/year and capital cost at CFAF 38 billion. The power station is interconnected with Ouagadougou via a 132-kV transmission line 285 km long, to which the power generated by the Bagré hydroelectric station will be delivered at a later stage.

4.24 Although the power generation figure used at the planning stage was 48.3 GWh/year, the most recent studies done by SONABEL and Electricité de France indicate a lower figure in light of more recent hydrological data, which give a lower flow rate. The corrected annual output is estimated at 33 GWh/year. This estimate is confirmed by ref. source 26, which calculates average generation of 33 GWh/year based on optimization of operating parameters. (See List of Reference Sources, items 9, 26 and 28).

4.25 The Kompienga project is still in the stage of filling of the lake to the maximum elevation of 180-181.5 m above sea level. During the last few years annual rainfall has not been sufficient to fill the reservoir to the calculated level. This means that even given normal rainfall it will take another two years before the power station is ready to enter into full production. Figure 16 shows the power generated by the Kompienga power station so far. The data are taken from SONABEL's annual report except for the 1992 figures, which are for projected output according to the Hydro Generation and Transmission Service. The SONABEL data indicate that the power station can reach total capacity when the reservoir elevation is between the optimum and maximum levels (177 m - 180 m).

FIGURE 16

Output of Kompienga Power Station, 1989-1992



D. Transmission Network

4.26 SONABEL operates a HV network limited to 132 kV, which is currently the highest voltage level. The network comprises 142 km of 132-kV transmission line between the Kompienga hydro power station and the Tenkodogo substation, 32 km of 132-kV line between the new Bagré hydro station and the Tenkodogo substation, and 143 km of 132-kV of line between Tenkodogo and the main Patte d'Oie substation at Ouagadougou.

4.27 There is a 132/33-kV, 5 MVA transformer at Tenkodogo which also supplies the station's LV auxiliary units. The transformer is intended to supply the city of Tenkodogo, located 11 km away, and, via a 40-km line, the 20-kV network of the cities of Koupéla and Pouytenga. The studies included analysis of an alternative line linking Kompienga with Bagré and running from there directly to Ouagadougou. This alternative was proposed prior to construction of the line from Kompienga. It would have produced substantial savings (estimated at CFAF 940 million) and allowed easier and more reliable operation of the 132-kV network. It is not clear why this solution was not considered. Even with the incremental costs for supply of Tenkodogo, 32 km of 33-kV line estimated at CFAF 10 million/km (1992), the difference would have represented estimated savings of CFAF 620 million.

4.28 A 90-kV line 90 km long has been built between the Ouagadougou network's Patte d'Oie station and the secondary center of Koudougou. Up to now the 90-kV transmission line has been operated at 33 kV, i.e. the sub-transmission level of the SONABEL network.

4.29 At the 33-kV level, SONABEL operates a network of overhead lines and buried cables at Ouagadougou which constitute the interconnections between the two power stations and the Kossodo and Patte d'Oie substations, the latter being the arrival point of the power generated by the hydro plants. A 33-kV interconnection between Bobo Dioulasso and Banfora is under construction, linking the Banfora generating units to the Bobo Dioulasso

network, including those of the self-producers located in the Banfora area. Figure 1 shows the transmission and sub-transmission networks operated by SONABEL in 1992. Figure 18 shows the single-phase set-up of the central region (Ouagadougou) networks.

E. Distribution Network

4.30 The secondary centers served by SONABEL are normally supplied by a local diesel-fired power station with a capacity of 150-300 kW. The power station generally comprises at least two sets (often mobile, to make it easy to move them elsewhere). The distribution system is constructed as a 20-kV overhead network with 50-160 kVA distribution transformers. The 20-kV network is strung on type H laminated-steel posts and insulated by glass insulators. The transformers are mounted on steel posts, with open-air make-and-break switch. The LV distribution network is composed of insulated and twisted four-wire overhead cables.

4.31 It is noted that many types of equipment other than the "standard" structure described above are used in the SONABEL system. Some of the secondary centers, established before 1986, are still served by a 5.5-kV distribution network. A number of others have 15-kV service, but the trend is mainly toward 20 kV and 30 kV. The recently electrified centers use 20 kV as the distribution network voltage. However, some established as 15-kV networks continue to be developed, including the Ouagadougou distribution network. The later conversion of these networks to 20 kV has to be prepared for a long time ahead to allow it to be done at minimum cost. It should be noted also that the solutions usually adopted in Burkina Faso are of a high technical level. There is therefore a need for detailed study of the possibility of using less expensive techniques, adapted to locally available materials, while continuing to offer a service of proper quality to the consumer.

4.32 In the SONABEL network, 220/380-V low-voltage electricity distribution is usually effected by means of overhead cables mounted on type H steel pylons with insulated conductor groups. Connections are made in accordance with similar standards, and the quality of service of the LV network seems to be adequate. In the large centers, Ouagadougou and Bobo Dioulasso, SONABEL is not in a position to comply within the normal time limits with all the connection requests received in the recently electrified neighborhoods; the reason for the delay is that SONABEL lacks the necessary financial resources for development of the network.

F. Connections and Network Extensions

4.33 In its task of making new connections, SONABEL faces two opposite problems: on the one hand, excessively large demand in some areas of Ouagadougou and Bobo Dioulasso; on the other, the need to stimulate sales and therefore to promote new connections in the secondary centers, on which economic viability depends. To enable it to cope with the two situations, the Distribution Service has shown great initiative and undertaken a number of noteworthy actions.

4.34 SONABEL organizes marketing campaigns in both the secondary centers and the newly electrified areas of the major cities. A SONABEL team conducts a selling campaign in a center lasting several days ("*Journées Commerciales*") visiting customers during which they are informed of the advantages of electricity service through personal interviews. The campaign is accompanied by various displays and promotional events in the village, such as sports contests between local people and SONABEL personnel which conclude with the distribution of prizes, "SONABEL" T-shirts, and so on. New customers are connected to the network immediately, and a campaign usually results in a fairly large number of new connections. This activity can be regarded as a successful venture on the part of the Distribution Service and should consequently be encouraged.

4.35 Concerning SONABEL's difficulty in meeting the very heavy demand for new connections in some large-city neighborhoods, the Distribution Service recently (1992) started a new scheme, in cooperation with consumer associations, of customer participation in the financing of network extensions in neighborhoods undergoing electrification. Under this scheme customers make a flat-rate payment which covers both the cost of the connection and extension of the network: the "extension" flat-rate payment is CFAF 80,000 to which is added the "connection" payment which is CFAF 40,000 for an ordinary single-phase connection, CFAF 60,000 for three-phase connection and CFAF 4,500 for the "rental" connection which gives access to the 3-Amp tariff. SONABEL collects the payment only if the consumer association of the street or neighborhood concerned has managed to assemble a sufficient number of customers wishing to be connected. Though it is still too early to assess the viability of this scheme, it seems that the experiment is being well received by the public.

4.36 SONABEL staff have not so far assessed the potential demand for new connections that SONABEL is unable to satisfy solely for lack of financial resources (the annual amount allocated by SONABEL to network extensions was CFAF 200 million until 1992; for the 1993 budget it has increased this to CFAF 800 million). It proved difficult to make such an estimate. An experimental program was therefore proposed, to be conducted by the Distribution Service in one or two areas of Ouagadougou. Test areas had to be selected with similar conditions to those of other, control areas. In the test areas, all necessary means will be deployed to comply with the connection requests in full. After a period of at least six months (or perhaps even a year) the necessary evidence will be available for an objective comparison of incremental connections in the test area and in the control areas, where the current formulas have continued to be applied. This resulting data are essential to realistic assessment of the external financial support needs for this task.

4.37 Another, quite recent development calls for more detailed examination. It was noted, particularly in certain secondary centers, that many houses--often recently built ones--were connected to the network but their occupants had not become subscribers. The Distribution Service has not offered any explanation for this behavior on the part of potential customers. The question needs to be examined whether this development reflects the impact of the new tariff system, in which the old rate brackets were dropped in favor of binomial tariffs including a fixed premium which, though reasonable in amount, might not suit a consumer who does not yet possess domestic appliances and whose electricity consumption is very low. Examination of these aspects could also lead the authorities to reconsider the policy of developing "3-Amp" connections, which durably limit the growth of consumption by small subscribers.

G. Ongoing System Development and Investment Program

4.38 At SONABEL, the process of developing generating, transmission and distribution infrastructures takes the form of execution of studies and start-up of construction on the most urgent projects. These projects are included in the investment program, with a 4-5 years time frame, and SONABEL's management then seeks the necessary financing to carry them out.

Bagré hydroelectric power station (under construction)

4.39 The main purpose of the Bagré project is to make better use of the land of the Nakambé Valley (Volta Blanche). It will bring irrigation to an area of 7,400 hectares. It includes an earth dam 30 m high, a 16-MW power station and a first irrigated perimeter section of 2,100 ha. The initial studies proposed that the power station would supply electricity for water pumping. Following the negotiations with the donors, the power station has been kept in solely to supply electricity to the Ouagadougou network. Management of project execution has been assigned to a specialized entity: the Bagré Project Authority. The power station is equipped with two 8-MW turbines and is connected by a 132-kV line, 32 km long, to the Tenkodogodo interconnection station, located on the Kompienga-Ouagadougou 132-kV transmission line. The various studies estimate electric power output at between 33 and 44 GWh/year; it will depend to some extent on the operating demands of the irrigation systems, which will have priority with respect to electricity generation.

Mini hydroelectric projects

4.40 The Banfora region, south of Bobo Dioulasso, offers a number of possibilities for the development of mini hydroelectric plants (power stations with capacities of between 100 and 1,000 kW. The Master Plan indicates six possible sites: Badadougou, Karfiguela, Niofila, Sindou, Tamassari and Tourni. A feasibility study of the Niofila power station was done in 1989 (see ref. source 29). The study proposes a 1-MW power station with an annual output of 4.5-5.0 GWh. The estimated capital cost per kW of installed capacity would be DM (Deutsche Mark) 10,160 and the dynamic cost price DM 307/MWh, equivalent to CFAF 52.2/kWh (1989). The calculation was based on an isolated network without connection between Bobo Dioulasso and Banfora. The Master Plan provided for connection of the region's mini hydroelectric plants to the 33-kV network. The planning of the Banfora area local network will need to be reviewed to take account of its interconnection soon to the western regional network with Bobo Dioulasso as principal center.

Interconnection between Burkina Faso and neighboring countries

4.41 Projects have been studied for interconnection between Burkina Faso and two neighboring countries: Côte d'Ivoire and Ghana. In addition, Burkina Faso forms part of a study of regional cooperation in electric power known as UPDEA Region "B." The talks with SONABEL revealed that the studies and discussions between the parties have focused more on technical questions and possibilities than on the mutual benefits of interconnection between Burkina Faso and either Côte d'Ivoire or Ghana.

4.42 It should be noted that SONABEL has made its choice of principle: normal transmission network voltages of 90 kV and 120 kV. Even if these voltages are proposed by the UPDEA organization, the use of 90 kV instead of 132 kV --already used for the lines between the two hydroelectric plants at Kompienga and at Bagré and Ouagadougou--remains to be justified. It would be in SONABEL's interest not to diversify the voltages too greatly, so as to limit the range of types of spare parts for line equipment, since the cost difference between the two voltage levels is negligible. These cross-border interconnection studies propose the use of 220 kV between Ferkessédougou and Bobo Dioulasso, a choice justified by the Côte d'Ivoire network and at the same time by the voltage of the future transmission line to Burkina Faso. In the case of interconnection between Burkina Faso and Ghana, the use is being discussed of 90 kV or 161 kV, the latter being the standard voltage of the Ghanian system. The choice to be faced will be that of building the line for 220 kV and operating it at 161 kV until 220 kV becomes truly necessary on this link. This solution will make it possible to extend the Ghanian network from Bolgatanga to Ouagadougou and reduce losses (instead of introducing transformation between 161 kV and 90 kV).

4.43 The basic frame of reference for development of the electric power transmission networks in Burkina Faso is the Master Plan The Plan proposes linking the secondary centers to one of the two regional centers so as to create a web around the principal center--Ouagadougou in the case of the central network and Bobo Dioulasso for the western network. The secondary centers concerned can then receive the power at lower cost since it is generated by large sets burning fuel oil. These interconnections are economically attractive only when the volume of energy consumed in the secondary centers concerned is such that the annual gain on the cost price of this energy exceeds the cost of amortizing the investment in the line. Figure 1 shows the very restricted network that exists today, while figure 2 diagrams a future network linking all the secondary centers with one of the two large centers, i.e. Ouagadougou or Bobo Dioulasso, which are in turn linked with neighboring countries.

Current investment program

4.44 The most recent investment program drawn up by SONABEL is dated June 1991 and has not yet been updated to take account of the most recent decisions. Annex II, table 15 shows the provisional revised program according to information received during the talks with SONABEL. The investment program includes two new thermal power stations, at Bobo Dioulasso (Bobo III) and Ouagadougou (Ouaga III). The investments for capacity expansion of the two regional centers have been retained in the revised investment program in view of the real need to expand and renovate the generating plant. In comparison with the official SONABEL program, the program shown in the table has been delayed by one or two years, especially with respect to the cross-border interconnection investments: the Côte d'Ivoire-Burkina Faso interconnection investments have been postponed to the years 1993-95 and the Ghana-Burkina Faso investments to 1995-96.

4.45 Noteworthy also is the item of CFAF 200 million a year for network expansion projects. According to the Distribution Service, this amount is not sufficient to meet the demand for connection of new customers. There is a backlog of connection requests equivalent to CFAF 1,200 million (1992). Increasing the funds allocated to investment in this sector could allow SONABEL to catch up on these requests (see also paras. 4.35 and 4.36).

FIGURE 17

SONABEL: Distribution of Investment, 1991-1997

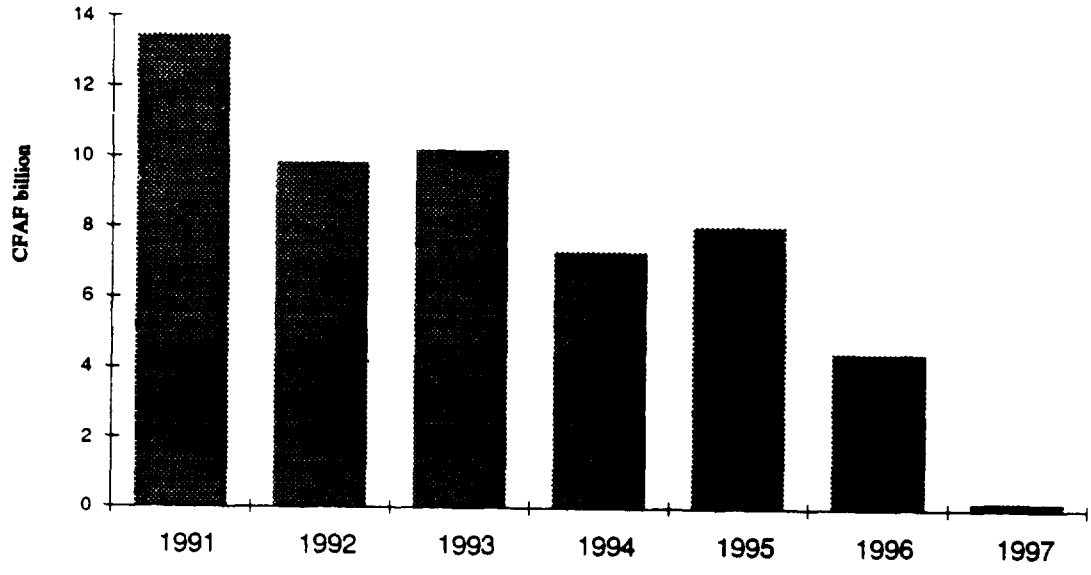
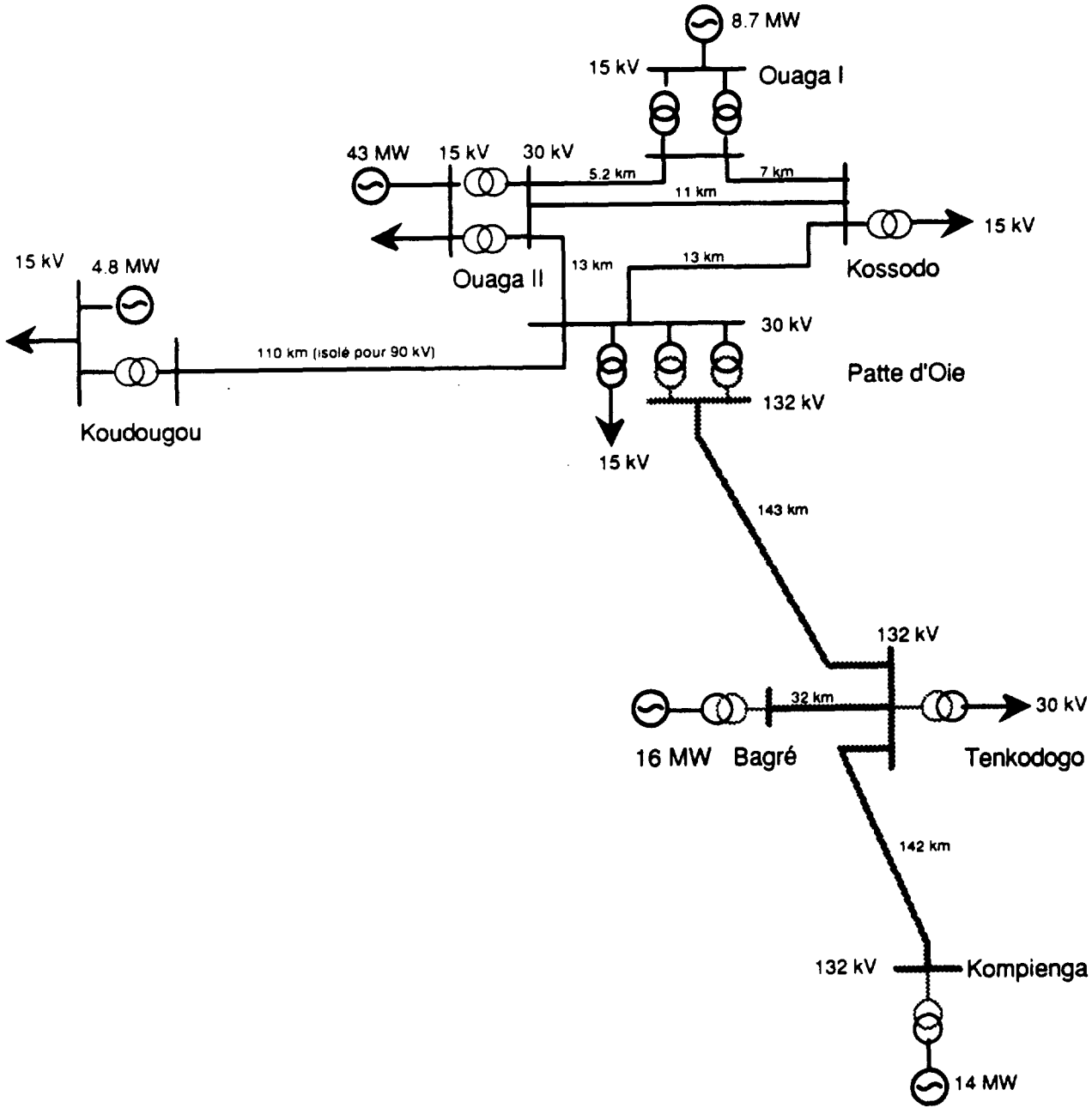


FIGURE 18

SONABEL: Central System, Single-Line Scheme



V. SONABEL FINANCES

Expenditure structure

5.01 The predominance of diesel thermal generation, based on imported fuels which have to be carried by land over a distance of about 1,000 km, makes the cost of fuel SONABEL's largest single expenditure item. Its share of total operating expenditure has fallen sharply in recent years, from 47 percent in 1987 to 33 percent in 1991. While this reduction is due in part to an exogenous factor, its achievement is due mainly to two internal factors:

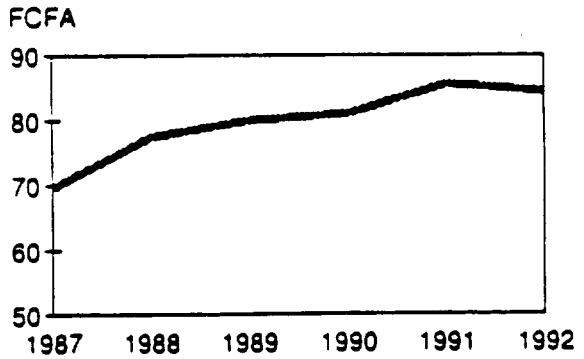
- the modernization of thermal generation, a large part of which is produced by new high-yield sets burning heavy fuel oil;
- the start of hydro generation in 1989 with the entry into service of the Kompienga power station. This plant has not yet reached its full production capacity since the reservoir could not be filled during the first two years of operation; maximum elevation will probably be reached during the 1992 flood season.

The decline in the share of fuel expenditure can be expected to continue in the years ahead with the entry into service of the Bagré hydroelectric station: by toward 1995 hydro plants will produce at least 30 percent of all electric power generated in Burkina Faso.

5.02 Lower fuel costs is, however, only one side of the story. The introduction of hydroelectric generation also raises plant amortization charges because of the relatively high construction cost of hydro stations. The addition to SONABEL's fixed assets of the Kompienga power station (book value CFAF 28.2 billion) and the Kompienga-Ouagadougou transmission line (CFAF 7.8 billion), with a combined fixed-asset value of CFAF 36 billion, boosted SONABEL's annual amortization charge by CFAF 1.14 billion. This charge is currently significantly higher than the fuel-cost savings contributed by the Kompienga power station. The introduction of hydroelectric generation does not, therefore, lower the cost price of the power but on the contrary raises it. (See figure 19).

FIGURE 19

Total Cost Price, 1987-1992
(CFAF/kWh)



5.03 Annex II, table 10 depicts the structure of operating expenditure for the years 1986 through 1991. An unusual increase took place during that period in certain items, notably expenditure on spare parts for power stations, which grew nine-fold in five years, from CFAF 124 million (2.7 percent of total operating expenditure) in 1986 to CFAF 1,156 million (7.7 percent) in 1991. (See para. 4.14).

5.04 Personnel expenditure also posted a fairly substantial increase, from CFAF 1.14 billion (12 percent of total operating expenditure) in 1987 to CFAF 2.58 billion (17 percent) in 1991. This increase in personnel expenditure, by an average of 22.6 percent a year over four years, reflects not only the growth of the labor force but also the rise in the average level of the total wage bill (including charges). At the same time this increase poses, even more sharply, the problem of controlling the size of the labor force and of overall personnel productivity already mentioned in para. 3.32. SONABEL's management will need to assign top priority to the task of containing personnel expenditures, and it is essential that all necessary measures be taken without delay to reduce their share in total operating expenditure, year by year.

TABLE 10

Personnel and Wage Costs

	1988	1989	1990	1991
Total labor force	1040	1122	1206	1244
- Managers	45	100	124	139
- Supervisors	184	146	159	161
- Operatives	811	876	923	922
Wage bill (CFAF million)	1688	1916	2258	2584
Average cost (CFAF 000/employee)	1619	1685	1875	2075

As the above table 10 shows, average wage cost per employee has risen in recent years by over 8 percent a year, outpacing the rise in the cost of living. This real wage increase will furnish SONABEL with the opportunity to strengthen its training and discipline demands on its employees and this in turn will help it improve the quality of the service it provides to its customers.

Receipts

5.05 Electricity sales, including meter rental, account for nearly 95 percent of SONABEL's receipts. The balance represents reimbursable work, such as connections and network extensions, the cost of which is borne by customers (4.5 percent), work done by the enterprise for its own account (0.3 percent) and miscellaneous proceeds. Energy billing prices were raised by 10 percent in October 1987 after having remained unchanged for four years. At the same time a tariff study was undertaken with the assistance of the consulting firm of EDF International. The new rates proposed by this study were introduced in two stages in 1990-91. They involve mainly modification of the tariff structure, without any significant change in the average selling price of electricity.

TABLE 11

Average Selling Price
(CFAF/kWh)

	1987	1988	1989	1990	1991
Energy billing	75.33	84.00	82.43	82.95	84.49
Meter rental	2.33	2.58	2.39	2.39	2.55
Total	77.66	86.58	84.77	85.34	87.04

Tariffs

5.06 SONABEL's tariff structure was recently overhauled in accordance with the recommendations of the 1988 study by EDF International. The rates are based on long-term marginal cost with the additional constraint, however, that they are uniform throughout the country. A surcharge of CFAF 4/kWh is included to defray public lighting and traffic light costs in the large population centers. The tariff structure includes a social tariff (known as the "3-Amp tariff") designed to allow access by small users at low prices. In the secondary centers the great majority of subscribers (60 percent) are on the 3-Amp tariff.

5.07 The tariff comprises a fixed component, which depends on subscribed power, and an energy component which depends on the number of kWh consumed. For large consumers there is a time-based tariff, i.e. a price varying with the time of day, which allows consumers to choose to consume electricity outside the peak hours. The actual tariff is augmented by a fixed monthly fee, also known as "meter rental", which varies according to the type of connection.

TABLE 12

Current Electricity Tariff, 1992
(Simplified Presentation)

Tariff	Fixed Monthly Charge CFAF/month	Power Premium CFAF/kW/month	Energy Component CFAF/kWh
Social Tariff (3 Amp)	881	--	68
General LV Tariff	265 1/	1030	72
Time-based LV Tariff	3895	1673	Peak: 108 Peak hours: 57
MV Tariff	4958	3739	Peak: 94 Peak hours: 43

1/ Monthly fee which varies with type of connection (single- or three-phase) and capacity category. The figure shown is for single-phase connection carrying up to 3 kW of subscribed power. The customer is also required to pay, at the time of connection to the network, the installation cost, the documentary expenses and a consumption deposit. (See Annex II, table 16).

Operating profit/loss history

5.08 SONABEL's operations have consistently produced a net financial profit, after deduction of profits tax (which is 45 percent in Burkina Faso), in recent years, including 1986 and 1987, i.e. before the tariff increase came into effect. The tariff increase was requested prior to the sharp fall in oil prices in 1986 and was applied effective October 1987 mainly as a preventive measure, since in reality it was not in fact necessary. Note that the Kompienga and Bagré hydroelectric projects were also started during the time of high oil prices; this explains their relatively poor return in the current economic context. The tariff study done by EDF International in 1988 moreover shows clearly that hydro generation currently tends to boost electricity cost, mainly owing to the financial expenses involved, and that this high charge will remain stable for a long period until the hydroelectric facilities have been fully amortized.

5.09 Non-operating receipts and expenditures have a significant impact on SONABEL's net financial result in each fiscal year. They include not only the draw-down of provisions for major repairs and various sums of an exceptional nature but also amortization of the various grants and equipment subsidies obtained from the government or under international cooperation. Moreover, SONABEL tends to inflate its non-operating accounts,

sometimes artificially, by including expenditures or receipts relating to previous years. We were not able to clarify a number of important points, including precise determination of the final operating profit/loss for recent years. The accounts, which are published by SONABEL annually in its reference documents, while fairly detailed, are not strictly identical, and we did not succeed in reconcile them fully (note, in Annex II, tables 10 and 11, that the operating result figures do not match for some years). On that point, it would be very useful to have the whole of SONABEL's accounts audited by an external auditor, since it is possible that some data processing operations need to be improved.

Balance sheet structure

5.10 The first item that strikes our attention in comparing SONABEL's balance sheets for the past few years is the sudden change in 1989, when physical fixed assets more than doubled with the entry into service of the Kompienga hydroelectric plant. This book value of this facility (including the Kompienga-Ouagadougou transmission line), CFAF 36 billion, by itself exceeded SONABEL's balance sheet total for the previous year (CFAF 28.2 billion).

TABLE 13

Fixed Assets
(CFAF billion)

	1986	1987	1988	1989	1990
Fixed Assets	15.9	18.0	18.4	53.7	53.0
Balance Sheet Total	22.2	25.2	28.2	65.5	67.5

The share of fixed assets in balance sheet total, which was of the order of 70 percent prior to 1988, rose to 80 percent after 1989.

5.11 This change is reflected on the liabilities side of the balance sheet in (a) a large increase in equity capital through an investment addition of CFAF 25.15 billion, representing the value of the grant of the fixed assets made available to SONABEL by the Government, and (b) a substantial increase in long-term liabilities, from CFAF 15.9 billion on December 31, 1988 to CFAF 27.7 billion on December 31, 1989. This radical change in orders of magnitude, on both the assets and liabilities sides, places the entire management of SONABEL in a new situation, in which purely financial problems become much more important than previously.

5.12 Among current assets, the figures point to a rapid deterioration in customers debtors from 1988 onward: this account tripled over three years, from CFAF 2.87 billion in 1987 to CFAF 8.62 billion in 1990. This is a highly negative situation, due only in part tolaxity by SONABEL, since the growth in customer debtors is attributable substantially to administration customers and therefore directly involves the responsibility of the government.

TABLE 14

Customer Debtors Account

	1986	1987	1988	1989	1990
Customer Debtors (CFAF billion)	2.96	2.87	4.79	6.89	8.62
Receipts equivalent (no. of months)	3.9	3.6	4.5	6.6	7.6

Cash situation

5.13 At first sight, comparison of current assets with short-term liabilities might suggest that SONABEL is in a sound cash situation since the short-term differential is positive and even widening strongly. The fact is, however, that this positive difference is buried for many months in customer debtors account, which makes the situation distinctly less satisfactory. SONABEL's cash situation actually continues to be rather tight, and the only normal lasting way to remedy it is to take all possible measures to reduce customer debtors. Unless such measures are applied energetically, SONABEL will inexorably be led to raise electricity rates for this reason alone, even though real electricity costs do not justify such an increase.

Self-financing capacity

5.14 The substantial increase in total amortization amount since 1989, together with the comfortable level of electricity rates since 1988, produces a relatively large gross self-financing margin, of the order of CFAF 4 billion. SONABEL has incurred heavy debt since 1989, however, with the result that debt service will absorb the greater part of this margin in the future. On the other hand, the institutional measures taken by the Government currently accord SONABEL favorable terms for repayment of its Kompienga project debts.

5.15 SONABEL's debt as of December 31, 1991 stands officially at CFAF 18.8 billion; this includes only a small portion of the debts contracted for construction of the Kompienga hydroelectric plant and the Kompienga-Ouagadougou transmission line. Compared with the total cost of these works of CFAF 36 billion, the debts charged directly to SONABEL amount to "only" CFAF 11.5 billion (see Annex II, table 12). Even this, however, involves financial expenses of CFAF 600 million, plus a principal repayment charge of the same order of magnitude effective 1994-95 onward. With these reliefs, SONABEL's total debt service is CFAF 2.7 billion in 1992 and will rise to CFAF 4.1 billion in 1994.

5.16 The periodic financial projections made by SONABEL in drawing up preparing its investment program for future years indicate that, under the current arrangements for repayment of the Kompienga project debts, SONABEL's financial resources only allow an investment self-financing rate of under 15 percent (see Annex II, table 14),

which is inadequate for sound financial management. Note however that the bases of SONABEL's financial projections include a number of disputable items, beginning with the investment program. A simple analysis of the investment program performed by SONABEL management in November 1992 led to a significant revision of the program through a more realistic approach to execution possibilities. (See Annex II, table 15).

5.17 Analysis of SONABEL's financial condition indicates that it is currently in fairly comfortable shape. This situation is however fragile and to a large extent artificial. The two basic factors that produce it, i.e. the investment program and the debt repayment provisions, will have a direct impact on the future development of electricity rates. This is therefore a matter of direct concern to the public authorities as well as to SONABEL itself and, to some degree, the donors.

5.18 In this connection, there is a need in particular to clarify the financial relations between SONABEL and the Government with a view to:

- making SONABEL assume direct responsibility for the debts deriving from the Kompienga power station and in general for all investments pertaining to electricity generation, transmission and distribution facilities;
- regularizing customer debtors account by paying off the arrears of the administration and governmental agencies;
- laying down clear arrangements and procedures in order to ensure regular payment of government electricity bills and avoid the build-up of new arrears in the future.

The first of these measures could of course necessitate adjustment of the already very high electricity rates.

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VI. POWER SECTOR DEVELOPMENT OUTLOOK

A. Energy Generation

6.01 A major objective of Burkina Faso's energy-sector development strategy is to supply electricity to the largest possible number of customers at lowest cost. This means that SONABEL must find ways to reduce generating cost in the future. A second strategic objective is to support development of the country's modern sector in both the large population centers and the villages.

6.02 Burkina Faso is poorly endowed with primary energy resources for developing electricity generation: hydroelectric resources, farming-residue fuels, and perhaps some coal resources according to recent exploratory work. It will therefore continue to depend in large measure on imported energy in the form either of petroleum products for its thermal plants or of electricity imported directly. The choices with respect to electricity generation or importation, based on the economic criterion stated above, will determine the directions of future structural development of the national electric power system.

6.03 The existing generating facilities do not offer much scope for reducing generating cost apart from fuel cost (fuel oil and gas-oil). On that point, Burkina Faso is currently studying the possibility of shipping fuel oil by rail instead of by road. However, although transportation accounts for 50 percent of fuel-oil price, reducing this price will do relatively little to lower total electricity cost. Hydroelectric generation is generally regarded as a very economical source of power; however, owing to geographic conditions in Burkina Faso hydro plants involve very heavy investment and their annual output does not come up to the sometimes over-optimistic figures stated in the projects. Since SONABEL has to amortize the loans required to build the hydroelectric plants, the total cost of the energy they produce can exceed that of the thermal plants in the large centers.

Hydroelectric resources

6.04 Both the Government and SONABEL itself sometimes treat developing hydroelectric power in Burkina Faso as a strategic objective. Currently, the site envisaged for an important future project is Noumbiel on the Mouhoun River (Volta Noire). This project provides for the construction of a dam and power station with an installed capacity of 60 MW in three generating sets. The project studies estimate output at 180-200 GWh/year. The reservoir created by the dam would have an area of 1,420 km^2, located partly in Ghana and partly in Burkina Faso.

6.05 The Noumbiel site is situated on the frontier between the two countries and its hydroelectric potential belongs to them in equal shares. They therefore need to have a mutual interest in this project to consider executing it. For Ghana, however, the Bui site, located

downstream on the same river and wholly within Ghana, seems to of greater interest. The Bui project, for which fairly detailed studies have already been done, uses a natural river gorge and leads to less land flooding and lower evaporation losses than the Noumbiel project. An alternative for Burkina Faso might be to negotiate bilateral development of the Bui project or of the Noumbiel + Bui combination.

6.06 The agreement to be negotiated between Burkina Faso and Ghana will need to take into account, *inter alia*, the impact of the Noumbiel project on the output both of the existing Akosombo power station and of the projected Bui hydroelectric plant. With regard to the Bui project, Coyne & Bellier (ref. source 3) have calculated that, despite the reduced flow due to evaporation, the river regulation provided by the Noumbiel dam boosts Bui's hydroelectric potential by about 60 GWh because flow regularization due to the Noumbiel reservoir raises turbinable volume at Bui above that obtainable there without Noumbiel. Evaporation on the Noumbiel reservoir would however lower annual flows at Bui, Akosombo and Kpong by some 500-800 million m^3/year. According to information supplied by the Volga River Authority (VRA), which is responsible for generation at Akosombo, this evaporation volume is equivalent to lost output of the order of 90-130 GWh in the Akosombo and Kpong power stations. Discussion is therefore needed between SONABEL and VRA in order to clarify this problem.

6.07 Study of the Bougouriba dam. In its search for alternative sites within Burkina Faso, SONABEL has conducted preliminary studies of hydroelectric development of the Bougouriba, a major tributary of the Mouhoun (Volta Noire). These preliminary studies (ref. source 42) call for a power station with two 6-MW turbine sets, a maximum fall of 30 m and output of 39 GWh/year. A variant of this project, with diversion of the Mouhoun at the Laissa site toward the Bougouriba basin, would allow incremental generation, raising the total output of this complex to 71 GWh/year.

6.08 SONABEL estimates the cost of the Bougouriba dam at CFAF 50 billion, based on an estimate by the Canadian studies firm of SNC but recalculated to take account of experience with the Kompienga dam. This means a cost of about US$16,600/kW of installed capacity, which is very high. The preliminary studies do not include assessments of the impact of this project on the other Volta Noire power stations.

6.09 There are currently a few small hydroelectric development projects of local importance (capacities up to 1.5 MW), including Niofila and Tourni in the southwest of the country, studied to the feasibility stage with the help of German Cooperation (see para. 4.40). It is pointed out however that Burkina Faso does not possess a true general inventory of hydroelectric resources with economic classification of the various projects. Such a study would be useful, especially in order to clarify long-term choices.

Thermal resources

6.10 The presence of graphite and carbonaceous shales in the Kaya region was indicated under the UNDP mining program in Burkina Faso. Some very brief studies of the shale were conducted as part of a UNDP natural resource mapping project in Burkina Faso. Black shales were found at several places near Koudougou, Kaya, Ouagadougou and Boulsa. The most notable examples are outcrops between Korsimoro and Boussuma. The UNDP

project studied the Datari site for possible utilization as fuel material. The data obtained are shown in Annex I.

6.11 A preliminary exploratory study of the feasibility of a power station located near the shale deposit and interconnected with Ouagadougou merits consideration. It would have to include a geological analysis of the potential of the fuel materials of the region, together with combustion tests on a pilot facility based on the fluidized-bed combustion technology used in another country and would need to clarify the environmental implications of the discharge of large quantities of graphite shale ash.

B. Importation of Electric Power

6.12 The most promising way to reduce electricity supply cost is to import it from neighboring countries that possess hydroelectric generating facilities or thermal plants with lower generating costs. The two studies concerning interconnection with Ghana and Côte d'Ivoire indicate that electric power can be obtained at lower prices by importing it than by producing it locally in Burkina Faso. Interconnection of the two large population centers Ouagadougou and Bobo Dioulasso with Ghana and Côte d'Ivoire, respectively, will make it possible to import a large part of the necessary electric power; in that case, the existing power stations could be held in reserve for Burkina Faso and the northern Ghana and Côte d'Ivoire regions. The essential question to be elucidated here is whether exportable electricity surpluses do in fact exist in the neighboring countries and if so whether these surpluses are structural and therefore stable or only temporary.

6.13 The studies concerning cross-border interconnection possibilities have shown that West Africa's electric power balance depends on output in Ghana. It should be noted that Ghana currently uses all the energy generated by the Akosombo and Kpong thermal plants and is busy examining the feasibility of thermal generation based on gas turbines and combined-cycle units. Ghana will not therefore be able to export electricity to neighboring countries in the immediate future, and the latter will have to face the possibility of an electric power shortfall during the years 1995-2000 unless it is decided to expand the network, for example by interconnection with Nigeria. While the closing of the VALCO aluminum plant at Tema could alter this outlook, negotiations with Ghana on the region's future energy situation continue to be necessary.

6.14 Other plans for development of the region will also have to be taken into consideration. Implementation of the Manantali project on the Senegal River could have interesting implications for energy supply of Bamako and later of Sikasso in Mali, which will bring this energy within a fairly short distance from the Bobo Dioulasso region (see figure 3).

Interconnection between Burkina Faso and Côte d'Ivoire

6.15 Studies concerning interconnection of Burkina Faso and Côte d'Ivoire were undertaken by Lahmeyer in 1985 and updated by Europe Power Systems (EPS) in 1992. The finding of these two studies is that 225-kV interconnection between Ferkessedougou (Côte d'Ivoire) and Bobo Dioulasso would be feasible for both parties. The basis of interconnection

would be supplying Bobo Dioulasso and other centers in western Burkina Faso and linking them in a regional network with the rural centers. The feasibility of network expansions within Burkina Faso has not been studied.

6.16 The 1985 study and its update in 1992 concluded that the most feasible solution would be to interconnect the two countries by a 225-kV line linking the Bobo Dioulasso center to the 225-kV network in northern Côte d'Ivoire. The study and the financial analysis for SONABEL show a good financial rate of return, in excess of 12 percent, provided that the transfer price delivered Bobo Dioulasso does not exceed CFAF 24/kWh in 1996. In comparison, the average price of generation at Bobo Dioulasso (with Banfora) used in the study is about CFAF 30 (1991).

6.17 The study recommends the following transfer tariff:

- a construction premium of CFAF 270 million/year, plus:
- a capacity premium of CFAF 12,000/kW/year, plus:
- a price prorated to the number of kWh delivered of CFAF 17/kWh.

The main advantage of interconnection for SONABEL is the reduction in the maintenance and operating costs of the electricity generation plants in the Bobo Dioulasso region from 1996 onward. The report calculates this reduction at CFAF 60 million/year, the difference between the cost of CFAF 270 million/year with diesel development and CFAF 210 million/year if the project is implemented. The reduction in the prorated cost of the power delivered to the network would be of the order of CFAF 3/kWh; this saving would make it possible to finance electrification of the region's secondary centers.

6.18 Total project investment cost is estimated at CFAF 15 billion (at current prices), shared between the two companies pro rata to the facilities built in each country: CFAF 4.9 billion in Côte d'Ivoire and CFAF 10.1 billion in Burkina Faso.

Interconnection between Burkina Faso and Ghana

6.19 A study of interconnection between Burkina Faso and Ghana was done by Tractebel, which presented its final report in April 1991. It seeks to clarify development of the Volta River Authority (VRA) 161-kV network in northern Ghana following the execution of important works in 1990 bringing the 161-kV network as far as Bolgatanga, near the border with Burkina Faso.

6.20 The basic hypothesis of the study is the importation by Burkina Faso of 10-20 MW, i.e. 60-120 GWh of electric power, to supply Ouagadougou. Several technical alternatives for interconnection lines were studied:

- 225-kV, 161-kV, 132-kV or 90-kV interconnection between Bolgatanga and Ouagadougou;

- 132-kV interconnection between Bolgatanga and Bagré;
- 161-kV interconnection between Bolgatanga and Tiebele (north of the border), 132-kV transformation, and 132-kV links to Ouagadougou and Bagré.

In its technical conclusions the report recommends an interconnection line between Bolgatanga and Ouagadougou but does not specify the voltage. The 132-kV voltage would suffice for the capacities to be taken into consideration during the next 20-30 years. In light however of the entirety of the conditions prevailing in the region, the technically and economically most suitable solution would be a 161-kV line linking the Patte d'Oie station in Ouagadougou directly to the Ghanian network. In view of Burkina Faso's wish to use the standardized 225-kV voltage in the future, a reasonable compromise would be to build this line in 225 kV and operate it at 161 kV for as long as this solution is satisfactory.

6.21 The capital cost of this interconnection, built in 225 kV and operated initially at 161 kV, would be about CFAF 5 billion. The electricity transfer price remains to be negotiated between the two parties. A summary cost-benefit analysis leads to a break-even price of the order of CFAF 13-15/kWh, which would give each of the two partners a rate of return equal to the overall project return.

C. Search for an Optimum Development Program

6.22 The various alternatives and projects discussed in the foregoing paragraphs represent alternatives to the "obvious" development solution, which is to install new diesel sets of suitable capacity in the various centers that have been or are due to be electrified. This development strategy, which--apart from the two hydroelectric plants, Kompienga and Bagré--has always been followed in Burkina Faso, represents the reference strategy since it is available on a practically unlimited scale. For any other strategy to be adopted, therefore, it will have to be economically more advantageous.

6.23 This principle of comparison has been applied in the planning studies done so far, including the 1987 Master Plan study, in assessing the merits of the various projects proposed: hydroelectric or cross-border interconnection projects. The findings validly indicate whether one or the other of these projects is more advantageous than the diesel development strategy. They do not however provide an assurance that the projects selected and in particular their execution sequence truly represent the optimum solution, that is, the least expensive (in terms of total discounted cost) of all possible solutions.

6.24 The reference thermal strategy can itself be optimized through the choice and unit capacity of the sets, on which the timetable of entry into service depends. In turn, the choice of unit capacity (which is sometimes linked to that of design type) strikes a balance among a package of factors, including internal operating arrangements, spare parts management organization, the mechanism of change-over of certain sets, and so on.

6.25 In order to comply with the objective of development at lowest cost (para. 6.01), therefore, SONABEL will need to perfect its planning approach. To do that it will have to introduce more refined planning methods and at the same time adopt an integrated

operational strategy that assures coherence in decision-making at all levels, for example between day-to-day operating procedures and investment decisions.

6.26 SONABEL's potential studies capacity will enable it henceforth to move on to the use of fairly comprehensive planning models, such as the WASP model, which employs a dynamic programming logic and is perfectly suited to study of predominantly thermal systems, with a rather limited number of hydroelectric plants, like that of Burkina Faso. With suitable technical assistance, SONABEL's planning staff will be able to assimilate these techniques fairly quickly.

Isolated centers and networks

6.27 The development of Burkina Faso's electric power system from a series of isolated centers to two regional networks and subsequent interconnection of these with neighboring country networks will also have to be carefully managed from the long-term perspective. In view of the present very poor coverage of the country, Burkina Faso's electrification development strategy will continue for a long time to be based on the formula of an isolated center, with a local distribution network, supplied by a small diesel power station. SONABEL's existing experience with the operation and development of small electrified centers is positive, and this activity will have to receive very close attention. The small-centers development strategy is also open to improvement, especially with respect to:

- equipment procurement, which will geared to limiting the number of sizes and construction types;
- better maintenance organization;
- developing a procedure for swapping sets so as to keep installed capacities constantly abreast of the development of demand.

6.28 A particularly important aspect of this evolution is following proper procedure in integrating isolated centers into the regional network. The construction of a 20-kV or 30-kV in order to connect an isolated center to the regional network must logically followed by immediate shut-down and dismantling of the local power station. This does not happen now at SONABEL, where the Koudougou power station, for example, remains in operation even though this center has been connected to the Ouagadougou network. The same situation will probably arise soon at Banfora. It is essential that operation of the isolated centers be converted without delay as soon as they are connected to the regional network so as to effectively obtain the benefits expected when it was decided to build the connection lines. Obviously, in some cases (which will depend on the type of consumers) involved the local power station can be held in reserve to ensure supply of priority consumers while the line is not available. In that case, however, this arrangement must be spelled out clearly set right from the study phase and taken into account in the economic analysis justifying construction of the line linking the center to the general network.

Development of distribution networks

6.29 The main problem in Burkina Faso at this time with respect to the development of distribution networks is the great diversity of average voltages (5.5, 15, 20 and 33 kV). This problem cannot be solved either easily or rapidly and it would serve no purpose to flatly decree a decision in favor of enforced standardization. Nevertheless, a policy needs to be adopted in this area in view of the plant and operating cost implications. A strategy study would need to be done in order to identify the factors that enter into the decision.

D. Tariff Policy and Development Financing

6.30 The current electricity rates tariff is based on the study conducted in 1988 with the help of the consultants EDF International, which examined the marginal costs of development of Burkina Faso's electric power system. The rates were worked out on the basis of these marginal costs but with the additional condition, imposed by the Government, that the rates shall be uniform for the whole country, without regional differentiation. Since marginal costs differ widely among the three systems (the Ouagadougou system, the Bobo Dioulasso system and the package of isolated centers), prescribing a single tariff means that the rates arrived at merely represent a compromise whose features no longer steer consumers to collectively optimum choices but simply enable SONABEL to break even on its costs. This raises the question of whether altering the tariff structure (abandoning segmented rates and introducing binomial rates, with an appropriate fixed premium) was justified.

6.31 The new tariff system was constructed on the basis of financial projections using 1993 as the reference year and is supposed to balance out costs over the period 1991-95 (provided the hypotheses used in the projections are borne out in practice). No provision has been made for indexing, which means that in 1995 the tariff will either have to be amended by the Government in exercise of its authority (at the request of SONABEL, which will have ascertained that the rates have become inadequate), or completely restudied. A much sounder solution would be to develop a system of indexing rates to take account of developments in the general economic environment.

E. Conclusion of a Contrat-Plan

6.32 The introduction of rates-indexing by reference to objective economic parameters is the cornerstone of a set of institutional measures through which SONABEL can be made accountable and be requested to act more vigorously to improve its management performance and to assume a significant share of responsibility for financing its development. A *contrat-plan* could be concluded between SONABEL and its supervisory agency embodying these measures, together with a number of more specific goals, including *inter alia*:

- achievement of prescribed service quality levels;

- improvement of productivity;
- execution of a given volume of new electrification works;
- achievement of an investment self-financing rate exceeding a specified minimum level;
- absorption of administrative and private customer arrears.

This would eliminate the possibilities--present in the current institutional structure--for slippage toward a subjective authoritarianism on the part of the Administration and provide the supervisory authority with the means to evaluate the performance of SONABEL's management team by reference to actual figures.

6.33 For the introduction of a *contrat-plan* to be effective, it needs to be preceded by a number of simple but essential institutional measures, including *inter alia*:

- clear definition of the duties and responsibilities of SONABEL's management team;
- appointment within the Government of a *contrat-plan* manager responsible, in accordance with clearly defined terms of reference, for ensuring compliance with the Government's contractual obligations to SONABEL;
- designation of an arbitration entity responsible for monitoring implementation of the *contrat-plan*, evaluating performance and, where necessary, issuing rulings binding on the two contracting parties.

The arbitration entity could be an ad hoc committee composed of representatives of SONABEL, the Government, the consumers and possibly certain donors. It would need to have a technical secretariat qualified to monitor SONABEL's activities and the process of implementation of the *contrat-plan* by the two parties.

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POSSIBLE USE OF GRAPHITE AND BLACK CARBONACEOUS SHALE STRATA IN THE KAYA REGION

During the discussions of the UNDP mining program in Burkina Faso the mission's attention was drawn to the availability of graphite and shale in the Kaya neighborhood. Very limited studies of the shale have been done, in conjunction with a UNDP natural resource mapping project in Burkina Faso.

Black shales have been found at a number of places near Koudougou, Kaya, Ouagadougou and Boulsa. The most striking formations are outcrops between Korsimoro and Boussuma. The UNDP project studied the Datari site for possible use as a fuel material.

There a several bands of black shales and black "graphitic" cherts in the UNDP project area. Graphitization of the (carbonaceous) material is incomplete. Shales with a content of more than 22 percent could be regarded as a potential energy source. A number of exploratory analyses were performed on the carbonaceous shales of Semapoum and Datari during the project. The results show that the carbon contents and calorific values of this rock are adequate for it to be used as a fuel material.

The UNDP report contains the following analysis of carbonaceous shale samples from the Datari site:

1. <u>Samples with water (Datari)</u>

Water (%)		1.04	1.89	1.45	1.51
Ash (%)	(Ash)	77.56	62.60	67.18	62.24
Fuel (%)	(100-W-A)	21.40	35.51	31.37	36.25
Volatiles (%)	($V+W_M+C$	5.59	4.60	4.74	5.25
Total hydrogen (%)	O_2)	0.53	0.42	0.43	0.47
Total carbon (%)	(H_t)	16.96	31.65	27.54	31.90
Total sulfur (%)	(C_t)	0.015	0.020	0.014	0.022
	(S_t)				
Max. calorific value (MJ/kg)	(Q_g)	5.274	10.141	8.799	10.313
Max. calorific value (MJ/kg)	(Q_g)	5.133	10.003	8.670	10.173

2. Samples without water (Datari)

Water (%)					
Ash (%)	(Ash)	78.38	63.17	68.17	63.19
Fuel (%)	(100-W-A)	21.26	33.19	31.83	36.81
Volatiles (%)	$(V+W_M+C$	5.65	4.69	4.81	5.33
Total hydrogen (%)	$O_2)$	0.54	0.43	0.44	0.48
Total carbon (%)	(H_t)	17.14	32.26	27.95	32.39
Total sulfur (%)	(C_t)	0.015	0.020	0.014	0.022
	(S_t)				
Max. calorific value (MJ/kg)	(Q_g)	5.329	10.336	8.928	10.471
Max. calorific value (MJ/kg)	(Q_g)	5.211	10.242	8.833	10.368

Owing to its low calorific value and its volatility percentage, black shale can be burned only using the latest fluidized-bed combustion technique.

The Finnish organization Ahlstrom Pyropower has conducted combustion tests with materials of the same nature and has found that the method works and is economically feasible. Israel has a 10-15 MW power station in commercial operation which uses similar fuels and the fluidized-bed combustion technique.

A feasibility study of a power station located near the shale deposit and interconnected with Ouagadougou, including geological analysis of the fuel materials potential in the region, would merit consideration. The feasibility study would have to include combustion tests on an existing pilot facility based on the fluidized-bed combustion technique and examine the environmental implications of the discharge of large quantities of graphitic-shale ash.

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Annexe II
Tableau 1

PRODUCTION D'ELECTRICITE, 1972 - 1991 (GWh)

Année	Ouagadougou	Bobo Dioulasso	Koudougou	Banfora	Ouahigouya	Autres centres	Total SONABEL
1972	21.6	9.6	5.4		0.32		36.9
1973	24.7	11.3	5.2	0.04	0.35		41.6
1974	27.8	13.2	5.2	0.74	0.37		47.3
1975	31.6	14.3	5.6	0.96	0.44		52.9
1976	35.2	16.4	6.2	1.14	0.58		59.5
1977	42.5	18.8	6.6	1.49	0.65		70.0
1978	49.4	21.0	7.4	1.70	0.83		80.3
1979	59.4	25.1	11.4	1.85	0.99		98.7
1980	68.5	28.4	12.9	1.86	1.12		112.8
1981	71.5	28.7	11.3	1.95	1.22		114.7
1982	78.5	29.8	11.4	1.84	1.33		122.9
1983	79.0	30.3	12.0	1.92	1.46	(2)	124.7
1984	74.5	30.5	12.9	1.64	1.70	1.92	123.2
1985	73.4	30.4	13.1	1.46	1.94	3.00	123.3
1986	77.6	33.1	12.0	1.54	2.04	(3 4.32	130.6
1987	83.3	36.3	12.0	1.62	1.97	5.51	140.7
1988	89.3	40.6	11.9	1.68	2.20	6.12	151.8
1989	(1) 99.3	41.6	11.5	1.79	2.47	7.66	164.3
1990	112.7	46.1	11.6	1.89	2.84	9.46	184.6
1991	120.4	45.9	11.9	2.06	2.85	10.10	193.2
Taux de croissance: (% par an)							
72 - 82	13.77	11.99	7.76		15.31		12.78
83 - 86		1.03			11.80		1.55
86 - 90	9.78	8.64		5.25	8.62	21.65	9.04

Notes:

(1) Y compris production de Kompienga: 1.58 GWh en 1989 et 9.31 GWh en 1990

(2) Centres mis en service 1983: Dori, Dédougou, Fada, Gaoua, Kaya, Tenkodogo, Tougan

(3) Centres mis en service en 1986: Koupela, Orodara, Yako, Po

Annexe II
Tableau 2

Evolution de la demande dans le systeme électrique central (Ouagadougou), 1986 - 1990

	1986	1990	Variation % par an
SYSTEME OUAGADOUGOU			
a. Production d'électricité, MWh			
Ouagadougou	77 606	103 350	
Koudougou	12 043	11 641	
Kompienga		9 696	
Total	89 649	124 687	8.6
b. Consommation des auxiliaires, MWh			
Ouagadougou	3 468	3 019	
Koudougou	846	581	
Kompienga	0	340	
Total	4 314	3 940	-2.2
Ratio consommation auxil. (b/a), %	4.81	3.16	
c. Energie vendue, MWh			
MT - Ouagadougou	36 934	47 718	
MT - Koudougou	9 641	7 891	
S - total MT	46 575	55 609	4.5
BT - Ouagadougou	32 873	52 164	
BT - Koudougou - Reo	1 539	2 476	
BT - Kompienga	0	232	
S - total BT	34 412	54 872	12.4
Total MT + BT	80 987	110 481	8.1
Structure de la consommation: (%)			
- MT	58	50	
- BT	42	50	
	100	100	
d. Rendement global (c/a), %	90	89	
Ratio pertes en réseaux %	4.85	8.23	
e. Nombres d'abonnés			
MT - Ouagadougou	215	249	
MT - Koudougou	15	18	
s - total MT	230	267	3.8
BT - Ouagadougou	18 054	30 753	
BT - Koudougou, Reo	1 981	3 049	
BT - Kompienga	0	300	
s - total BT	20 035	34 102	14.2
Total MT + BT	20 265	34 369	
Consommation moyenne par abonné BT, kWh/an	1 718	1 609	

Annexe II
Tableau 3

Evolution de la demande dans le systeme électrique ouest (Bobo Dioulasso), 1986 - 1990

	1986	1990	Variation % par an
SYSTEME BOBO DIOULASSO			
a. Production d'électricité, MWh			
Bobo Dioulasso	33 147	46 062	
Banfora	1 539	1 885	
Total	34 686	47 947	8.4
b. Consommation des auxiliaires, MWh			
Bobo Dioulasso	864	1 771	
Banfora	109	103	
Total	973	1 874	17.8
Ratio consommation auxil. (b/a), %	2.81	3.91	
c. Energie vendue, MWh			
MT - Bobo Dioulasso	18 410	23 734	
MT - Banfora	215	172	
S - total MT	18 625	23 906	6.4
BT - Bobo Dioulasso	10 738	13 868	
BT - Banfora	1 054	1 452	
S - total BT	11 792	15 320	6.8
Total MT + BT	30 417	39 226	6.6
Structure de la consommation: (%)			
- MT	61	61	
- BT	39	39	
	100	100	
d. Rendement global (c/a), %	88	82	
Ratio pertes en réseaux %	9.50	14.28	
e. Nombres d'abonnés			
MT - Bobo Dioulasso	80	91	
MT - Banfora	13	7	
s - total MT	93	98	1.3
BT - Bobo Dioulasso	9 780	14 708	
BT - Banfora	1 947	2 673	
s - total BT	11 727	17 381	10.3
Total MT + BT	11 820	17 479	
Consommation moyenne par abonné BT, kWh/an	1 006	881	

Anexe II
Tableau 4

Evolution de la demande dans les centres isoles 1986 - 1990

	Production [MWh]	Consom.de combustib. [g/kWh]	Consom. auxiliaires [%]	Ventes MT [MWh]	Ventes BT [MWh]	Rendem. global [%]	Nombre abonnés MT	Nombre abonnés BT
Ouahigouya	2 044.8	232.0	2.2	307.2	1 073.7	67.5	13	2 018
Dedougou	1 285.6	321.0	5.3	757.2	445.3	93.5	5	723
Tougan	220.2	323.0	7.8	57.4	139.7	89.5	2	334
Fada NGourma	636.3	299.0	6.5	137.5	397.7	84.1	4	423
Gaoua	377.4	326.0	1.7	153.9	174.0	86.9	5	304
Kaya	615.3	306.0	0.6	181.4	332.7	83.6	5	688
Dori	288.5	343.0	0.8	47.8	220.2	92.9	1	425
Tenkodogo	688.3	285.0	2.4	108.2	483.5	86.0	4	519
Yako	14.2	n.s.	n.s.	-	7.4	n.s.	-	18
Koupela	27.7	n.s.	n.s.	-	16.5	n.s.	-	41
Orodara	17.5	n.s.	n.s.	-	8.0	n.s.	-	20
Po	16.5	n.s.	n.s.	-	9.9	n.s.	-	25
Total	**6 232.3**	*285.1*	*3.4*	**1 750.6**	**3 308.6**	*81.1*	**39**	**5 538**
Ouahigouya	2839.5	263	8.58	533.6	1808.5	82.5	10	2 928
Dedougou	2721.8	273	2.71	1497.7	877.5	87.3	10	1 439
Tougan	384.1	319	1.34	44.3	270	81.8	2	512
Fada NGourma	961	267	0.48	185.4	636.3	85.5	8	769
Gaoua	572.2	281	9.77	218.9	250.1	82	6	571
Kaya	1110.7	260	0.56	287.4	695.1	88.5	7	1 038
Dori	629.5	295	0.76	72	488.5	89	5	701
Tenkodogo	1059.8	273	1.98	191.4	736.8	87.6	5	940
Yako	442.6	288	0.44	61.8	341	95.3	2	414
Koupela	749.8	289	1.17	28.6	623.4	87	2	588
Orodara	184.6	315	1.87	28	125.8	83.3	1	304
Po	305.5	278	1.59	86	195.6	92.2	5	243
Total	**11961.1**	*274.2*	*3.63*	**3235.1**	**7048.6**	*86.1*	**63**	**10 447**
Variation %/an	**17.70%**	*-0.97%*	*1.43%*	**16.59%**	**20.81%**	*1.51%*	**12.74%**	**17.20%**

Annexe II
Tableau 5

Prévisions de la demande, faites dans les études anterieures

		1990	1995	2000	2005	2010	2015	2020
Schéma Directeur								
Ouagadougou	Max	81.9	115	161.2				
	Min	67.5	78.2	90.7				
Bobo Dioulasso	Max	36.6	52.7	77.4				
	Min	29.6	34.3	39.8				
Koudougou	Max	35.7	41.4	48				
	Min	12.8	14.9	17.2				
Banfora	Max	1.5	20.9	25.5				
	Min	1.2	1.4	1.7				
Ouahigouya	Max	2	3.1	4.8				
	Min	1.7	2.2	2.7				
7 Centres sec. (83)	Max	5.3	9.8	18.1				
	Min	4.7	7.5	12.1				
4 Centres sec. (86)	Max	4.2	7.7	14.2				
	Min	1.9	3	4.8				
Total:	Max	167.2	250.6	349.2				
	Min	119.4	141.5	169				
Etude tarifiare								
Ouagadougou		80.8	98.1					
Koudougou		18.4	21.6					
Bobo Dioulasso		34.4	43.5					
Banfora		1.5	1.7					
Autres centres		7.3	9					
	Total	142.4	173.9					
Etude Interconnexion Ghana - Burkina Faso								
Ouagadougou		88.3	106.9	131.3	163.9	206.1	261.6	
Koudougou		14	16.9	19.8	22.7	25.6	28.5	
Bobo Dioulasso		36	45.2	55.3	67.7	83.3	102.5	
Banfora		1.4	10.7	12.4	14.4	16.7	19.3	
Total		139.7	179.7	218.8	268.7	331.7	411.9	
Sonabel (1992)								
Ouagadougou	Max	99.9	135.91	191.3	289.83			
	Min	99.9	118.9	141.38	168.2			
Koudougou	Max	10.4	13.39	179.32	269.83			
	Min	10.4	12.9	141.38	168.2			
Bobo Dioulasso	Max	37.6	51.2	69.8	95.1	127.3	170.3	227.9
	Min	37.6	47	55.5	65.6	76	88.1	102.2
Banfora	Max	1.6	13.6	16.9	21.4	27.8	36.4	48.1
	Min	1.6	13.2	15.1	17.5	20.6	24.1	27.9
Total	Max	149.5	214.1	457.32	676.16			
	Min	149.5	192	353.36	419.5			

Annexe II
Tableau 6

Bilan Energetique Général, 1990 (ktep)

	Bois de feu 1)	Déchets végétaux 2)	Electricité 3)	Charbon de bois	GPL	Essence	Kerosène et Jet	Gasoil DDO	Fuel	Total
Energie primaire:										
Production	1825	100	0.8							**1925.8**
Importation					2.4	67.6	27.2	74.5	29.9	**201.6**
Total énergie primaire										**2127.4**
Conversions:										
Production d'électricité										
- SONABEL			15.1					-14.7	-26.8	**-26.4**
- Autoproducteurs		-4	5.3					-12.9		**-11.6**
Production charbon de bois	-20			8						**-12**
Total disponible	1805	96	21.2	8	2.4	67.6	27.2	46.9	3.1	**2077.4**
Pertes			2							**2**
Consommation:										
- Ménages	1805	50	4.2	8	2.4		15			**1884.6**
- transports						67.6	12.2	37.9		**117.7**
- Industrie, agriculture, services		46	15					9.6	3.1	**73.7**

1) Bois de feu: 500 kg/habitat/an; 1 tonne bois = 0.4 tep; Population 9,126 millions
2) Déchets végétaux: 68 000 tep paille, 2 000 tep déchets karité, 25 000 tep bagasse, 5 000 tep déchets coton
3) 1 GWh = 86 tep. Production 1990: SONABEL 184,6 GWh, dont 9,31 GWh production hydraulique. Autoproducteurs 62 GWh, dont 12 GWh à partir de déchets végétaux

Tableau 7: Equipement du production thermique

Reseau	Centrale	Mis en service	Puissance nominale kVA	Puissance maximale kW	Disponi-bilité totale	Production maximale par an	Années en service (1992)	Heures de l'operation (1986)	Coût du kWh FCFA	Energie produite (1991)	Coefficient de charge moyen, Kc	Nb d'heures de marche du centrale
	Ouaga 1	1991	3375	2700		0	1					
	Ouaga 1	1991	3375	2700			1					
	Ouaga 1	1964	2190	1500	0.73	9592200	28					
	Ouaga 1	1965	2190	1500	0.73	9592200	27					
	Ouaga 1	1972	1875	1500	0.73	9592200	20					
	Ouaga 1	1978	1875	1500	0.73	9592200	14					
Ouaga 1			14880			38368800			31.80	21,776,252	78.13	2341.382625
	Ouaga 2-1	1975	4000	2800	0.73	17905440	17	24382				
	Ouaga 2-3	1978	6600	4735	0.78	32353308	14	22340				
	Ouaga 2-4	1979	6600	4735	0.78	32353308	13	30324				
	Ouaga 2-2	1980	6600	4735	0.78	32353308	12	20663				
	Ouaga 2-5	1982	9990	7190	0.78	49127832	10	19132				
	Ouaga 2-6	1982	9990	7190	0.78	49127832	10	17919				
Ouaga 2			43780			213221028			25.20	85,979,700	66.33	3701
	Koudougou-1	1969	750	600	0.73	3836880	23	63991				
	Koudougou-2	1969	750	600	0.73	3836880	23	64473				
	Koudougou-3	1969	750	600	0.73	3836880	23	73792				
	Koudougou-4	1979	1600	1300	0.78	8882640	13	29714				
	Koudougou-5	1979	1600	1300	0.78	8882640	13	26597				
Koudougou			5450			29275920			33.37	11,933,310	61.11	4479
	Kompienga	1989	7000	5600		16500000	3					
	Kompienga	1989	7000	5600		16500000	3					
Kompienga			14000			33000000				12,623,310		
	Tenkodogo	1983	110	88	0.6	462528	9					
	Tenkodogo	1989	320	256	0.6	1345536	3					
	Tenkodogo	1990	200	160			2					
Tengodogo			630			1808064			36.70	959,507	52.21	3646
	Po	1986	120	96			6					
	Po	1986	60	48			6					
Po			180						37.72	333,210	60.08	3851
	Kaya	1983	110	88			9					
	Kaya	1986	320	256			6					
	Kaya	1989	200	160			3					
Kaya			630						39.86	1,082,649	55.27	3887

Annexe II
Tableau 7
Page 1

Tableau 7: Equipement du production thermique

Reseau	Centrale	Mis en service	Puissance nominale kVA	Puissance maximale kW	Disponi-bilité totale	Production maximale par an	Années en service (1992)	Heures de l'operation (1986)	Coût du kWh FCFA	Energie produite (1991)	Coefficient de charge moyen, Kc	Nb d'heures de marche du centrale
	Dori	1983	110	88			9					
	Dori	1986	110	88			6					
	Dori	1991	320	256			1					
Dori			**540**						37.02	745,827	47	3673
	Dedougou	1958	650	520			34					
	Dedougou	1986	320	256			6					
	Dedougou	1991	500	400			1					
	Dedougou	1990	570	456			2					
Dedougou			**2040**						40.63	2,916,880	57.75	3095
	Ouahigouya	1983	320	256			9					
	Ouahiguya	1990	570	456			2					
	Ouahigouya	1982	140	112			10					
	Ouahigouya	1958	550	440			34					
Ouahigouya			**1580**						42.87	2,852,243	62.91	3587
	Tougan	1990	60	48			2					
	Tougan	1989	110	88			3					
	Tougan	1990	320	256			2					
Tougan			**490**						48.07	423,730	25	4324
	Yako	1986	120	96			6					
	Yako	1986	60	48			6					
	Yako	1982	110	88			10					
Yako			**290**						43.22	537,548	60.18	3850
	Bobo 1-1b	1972	1375	1100			20	11735				
	Bobo 1-1	1972	1375	1100			20	58744				
	Bobo 1-7	1976	1875	1500			16	44073				
	Bobo 1-8	1976	1875	1500			16	42686				
	Bobo 1-9	1977	1875	1500			15	40870				
	Bobo 1-3	1960	750	600			32	107163				
Bobo 1			**9125**						34.94	17,502,100	77.53	3092
	Bobo 2-1	1988	4760	3808			4					
	Bobo 2-2	1990	4760	3808			2					
Bobo 2			**9520**						26.25	28,363,704	75.93	4905

Tableau 7: Equipement du production thermique

Reseau	Centrale	Mis en service	Puissance nominale kVA	Puissance maximale kW	Disponi-bilité totale	Production maximale par an	Années en service (1992)	Heures de l'operation (1986)	Coût du kWh FCFA	Energie produite (1991)	Coefficient de charge moyen, Kc	Nb d'heures de marche du centrale
	Banfora	1991	700	560			1					
	Banfora	1974	450	360			18					
	Banfora	1990	160	128			2					
Banfora			**1310**						38.78	2,057,310	48.78	4024
	Gaoua	1983	110	88			9					
	Gaoua	1983	110	88			9					
	Gaoua	1991	320	256			1					
Gaoua			**540**						43.12	655,490	46.61	3255
	Orodara	1986	120	96			6					
	Orodara	1982	60	48			10					
Orodara			**180**						44.84	228,962	45.39	3503
	Koupela	1986	120	96			6					
	Koupela	1986	120	96			6					
	Koupela	1991	320	256			1					
Koupela			**560**						36.88	846,730	49.48	3820
	Fada	1990	110	88			2					
	Fada	1986	320	256			6					
	Fada	1990	200	160			2					
Fada			**630**						37.18	1,093,940	59.76	3632
Puissance totale installé			**106355**	**85084**								

Annexe II
Tableau 8

Exploitation des centrales thermiques 1990

Centrale	Energie produite	Energie livrée	Consomm auxiliaire	Consomm spécifique grammes/kWh		Coût comb. + huile
	GWh	GWh	%	Combust	Huiles	FCFA/kWh
Ouaga 1	4.338	4.134	4.7	256	2.58	35.49
Ouaga 2	99.012	96.247	2.79	228	3.21	25.62
Koudougou	11.641	11.06	4.99	241	3.14	33.86
Système central, total:	**114.99**	**111.44**	**12.48**	**230**	**3.18**	**26.83**
Bobo 1	13.495	12.845	4.82	261	2.54	36.12
Bobo 2	32.567	31.446	3.44	237	3.43	28.68
Banfora	1.885	1.782	5.46	276	1.73	39.95
Système ouest, total	**47.947**	**46.073**	**13.72**	**245**	**3.11**	**31.22**
Ouahigouya	2.839	2.596	8.56	262	2.06	40.49
Dedougou	2.722	2.648	2.72	273	1.94	41.55
Tougan	0.384	0.379	1.3	319	3.03	44.18
Yako	0.423	0.421	0.47	288	1.89	39.33
Koupela	0.75	0.741	1.2	289	1.64	39.4
Fada	0.961	0.956	0.52	267	1.45	36.34
Tenkodogo	1.06	1.039	1.98	273	1.3	37.08
Dori	0.63	0.625	0.79	295	2.59	40.77
Kaya	1.101	1.104	0.63	260	1.29	38.21
Po	0.306	0.301	1.63	278	1.43	37.83
Gaoua	0.572	0.567	0.87	281	1.5	42.54
Orodara	0.185	0.181	2.16	315	3.25	46.26
Centres secondaires	**11.933**	**11.558**	**22.83**	**274**	**1.86**	**40.03**
Total SONABEL	**174.87**	**169.07**	**49.03**	**237**	**3.07**	**28.93**

Annexe II
Tableau 9

Chiffres Caracteristiques d'exploitation

ELECTRICITE	1986	1987	1988	1989	1990	1991	1992
Production , GWh	130.6	140.7	152.1	164.3	184.6	193.2	200.9
Production thermique, GWh	130.6	140.7	152.1	162.7	175.3	180.6	180.9
Production hydraulique, GWh				1.6	9.3	12.6	20.0
Energie livrée des centrales	125.1	135.1	146.1	158.7	178.1	185.8	192.7
Ventes , GWh	116.5	123.9	136.5	148.1	160.0	169.1	175.7
- en MT	67.0	66.50	76.30	84.30	82.80		
- en BT	49.5	57.4	60.2	63.8	77.2		
Rendement global, %	89.2	88.1	89.8	90.2	86.7	87.5	87.4
Nombre d'abonnés	37,558	41559	46569	55267	62104	69767	77142
- en MT	362	373	382	414	428	453	456
- en BT	37,196	41186	46187	54853	61676	69314	76686
Consommation moyenne							
Par abonné, kWh/an	3,102	2,982	2,932	2,680	2,576	2,424	2,277
Par abonné MT, MWh/an	185.1	178.3	199.7	203.6	193.5		
Par abonné BT, kWh/an	1,331	1,394	1,303	1,163	1,252		
COMBUSTIBLE							
Consommation totale, tonnes		34549	36296	38912	41510	42679	42870
Consommation spécifique, g/kWh	247.0	245.6	238.7	239.2	236.8	236.3	237.0
PRIX DE REVIENT DU kWh VENDU (CFA/kWh)							
Combustibles et lubrifiants	43.90	37.74	33.12	32.08	31.75	32.25	26.91
Pièces de rechange, centrales	1.07	2.10	3.16	1.72	3.57	6.84	6.08
Pièces, matériels, réseau distrib.	2.14	1.64	2.29	2.41	2.95	3.48	2.13
Frais de personnel	8.86	9.20	12.37	12.94	14.11	15.28	15.64
Autres depenses	7.21	6.06	9.72	8.64	10.21	8.43	6.77
Amortissements et provisions	9.55	12.91	16.88	22.18	18.51	19.36	26.05
Total prix de revient , CFA/kWh	72.73	69.66	77.53	79.97	81.11	85.64	83.58

22-sep-93
Révisé provisoirement (Anneé 1992)

Annexe II
Tableau 10

Comptes d'exploitation SONABEL

	1986	1987	1988	1989	1990	1991	1992
DEPENSES							
Gasoil,DDO	3 453.2	3 149.1	2 301.8	2 052.6	2 004.7	2 433.1	1 651.5
Fuel	1 468.9	1 341.3	1 981.4	2 459.4	2 739.9	2 545.9	2 772.7
Huiles	203.2	186.9	238.5	240.1	335.5	474.6	303.7
Eau pour centrales	41.0	53.9	61.1	48.8	40.1	31.3	75.6
Pièces de rechange, centrales	124.1	260.8	430.9	254.2	571.7	1 156.4	1 067.8
Pièces, matériels, réseau distrib.	249.3	203.7	312.1	356.9	472.2	589.0	374.6
Autres matières et materiels	433.5	596.2	517.2	491.7	1 156.6	621.5	528.6
Transports consommés	40.4	30.4	12.6	15.9	34.6	57.4	46.8
Autres services consommés	480.7	509.9	741.1	698.9	725.7	648.3	592.9
Charges diverses	34.4	32.8	69.6	76.8	66.7	91.5	70.1
Frais de personnel	1 032.2	1 140.6	1 688.5	1 916.1	2 258.0	2 584.1	2 747.7
Impôts et taxes	33.8	44.0	115.9	77.2	126.9	114.0	71.0
Charges financières	238.7	402.6	663.0	523.0	462.0	432.4	412.9
Dotations aux amortissements	1 089.5	1 295.9	1 486.0	2 785.9	2 761.8	3 080.2	3 674.9
Dotations aux provisions	23.2	303.5	528.8	500.0	200.0	194.6	901.0
Total charges d'exploitation	8 946.1	9 551.5	11 148.4	12 497.6	13 956.2	15 054.4	15 291.8
Charges hors exploitation	76.6	125.9	732.9	314.8	350.1		1 186.9
Charges totales	9 022.8	9 677.4	11 881.3	12 812.4	14 306.3	15 054.4	16 478.7
RECETTES							
Ventes d'énergie	8 199.9	9 402.8	11 567.3	12 431.4	13 436.4	13 877.2	14 942.9
Location compteurs	309.6	288.4					
Produits divers	48.8	52.5	638.2	516.7	520.7	140.7	1 026.5
Interets reçus	0.8	1.6	2.1	5.2	9.3	25.5	28.3
Travaux remboursables	428.7	817.3	726.1	611.3	927.8	502.7	530.0
Travaux faits pour l'entreprise-même	34.3	31.5	36.5	41.7	51.8	67.1	78.6
Produits hors exploitation	332.9	169.0	15.3	949.8	855.7		1 206.0
Plus ou moins-values de cessions	2.0	- 5.3	20.8	11.1	0.0		0.0
Total produits	9 357.0	10 757.8	13 006.3	14 567.2	15 801.6	14 613.1	17 812.3
RESULTAT							
Resultat brut	334.3	1 080.4	1 125.0	1 754.8	1 495.3	- 441.2	1 333.6
Impot sur bénéfice (45 %)	133.7	486.2	506.2	789.6	672.9	0.0	600.1
Resultat net	200.6	594.2	618.7	965.1	822.4	- 441.2	733.5

Note:
Valeurs collectées par la mission et des commentaires supplementaires par M. Magaye Gaye pour 1986 - 1990.
Puor 1991 et 1992 données tres incomplètes

Annexe II

Bilans SONABEL

Tableau 11

	1986	1987	1988	1989	1990	1991	1992
ACTIF							
IMMOBILISATIONS						Des données 1991 manque	
Immobilisations incorporelles	34.3	19.2	1153.7	1019.8	758.4		389.0
Terrains	31.2	31.2	29.8	29.8	29.8		36.1
Autres immobilisations corporelles	13622.2	14515.9	16790.8	51353.5	50601.6		51601.7
Immobilisations en cours	2102.7	3296.4	229.7	1048.4	1262.9		3495.9
Autres valeurs immobilisées	131.4	167.2	219.0	208.3	309.0		207.5
S-Total	15921.9	18029.9	18423.0	53659.8	52961.7	0.0	55730.2
VALEURS D'EXPLOITATION							
Stock matières, fournitures	2000.7	2375.3	2510.9	2458.7	3149.8		5286.7
Emballages	0.6	0.6	0.6	0.6	0.6		0.0
Produits et travaux en cours	142.1	26.7	249.7	46.4	295.6		100.6
S-Total	2143.3	2402.6	2761.1	2505.7	3445.9	0.0	5387.3
VALEURS REALISABLES ET DISP.							
Avances versés aux fournisseurs	81.9	148.1	234.5	305.3	397.7		970.6
Clients	2959.6	2874.0	4792.0	6890.6	8617.5		8255.3
Personnel	61.1	126.6	164.0				82.9
Etat et Organismes Internationaux	60.2		29.3				
Débiteurs divers	400.9	430.2	482.8	136.8	137.2		123.3
Autres valeurs réalisables	93.2	115.7	164.2	132.9	141.1		277.9
Comptes de régularisation actif	52.1	55.9	0.3	118.8	720.1		
Banques	365.0	959.0	1124.4	1687.2	984.3		1606.9
Caisse	1.4	12.3	9.9	3.1	1.1		4.0
Accréditifs	12.0	16.7	4.0	45.9	49.0		
S-Total	4087.3	4738.7	7005.4	9320.7	11047.9	0.0	11320.9
PERTE de l'exercice							
TOTAL	**22152.5**	**25171.1**	**28189.5**	**65486.2**	**67455.6**	**0.0**	**72438.4**
PASSIF							
CAPITAL ET RESERVES							
Capital social	1387.6	1387.6	1387.6	1387.6	1387.6	1387.6	1387.6
Dotations	4386.6	5099.5	5826.0	31059.5	31978.9		32986.3
Réserves	34.2	34.2	34.2	205.4	398.4		625.9
Repport à nouveau	-1122.5	-922.0	159.7	583.3	1049.1		1595.5
S-Total	4685.9	5599.4	7407.5	33235.8	34814.1	1387.6	36595.3
AUTRES CAPIT. PERMANENTS							
Subvention d'équipement	2074.4	3688.1	4304.1	4412.8	4543.6		3955.1
Provision pour pertes et charges	5692.4	5692.4	6192.4	6192.4	5892.4		6601.3
Dette à long terme	5392.5	5255.4	5445.7	17133.4	16888.6		19488.6
S-Total	13159.3	14635.8	15942.2	27738.5	27324.5	0.0	30045.0
DETTE A COURT TERME							
Fournisseurs	2390.6	2556.2	1650.1	1221.7	1446.4		2851.1
Personnel	57.6	68.1	61.9	16.1	22.8		21.9
Etat et Organismes Internationaux	356.3	637.0	850.8	948.5	1131.4		635.6
Créditeurs divers	351.2	356.0	408.3	436.5	783.0		662.0
Compte de régularisation passif	176.7	249.5	579.3	923.9	1110.8		461.1
Emprunts à moins d'un an	575.5	474.2	433.5				583.5
Effets à payer	198.9	45.0					16.0
Banques							146.3
S-Total	4106.7	4386.0	3983.8	3546.7	4494.5	0.0	5377.5
BENEFICE de l'exercice	200.5	549.9	856.0	965.1	822.5		420.7
TOTAL	**22152.5**	**25171.1**	**28189.5**	**65486.2**	**67455.6**	**1387.6**	**72,438.5**

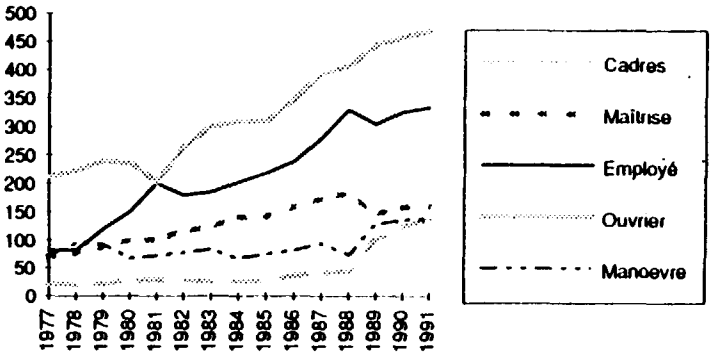
Tableau 12: Situation des emprunts de SONABEL au 31. décembre 1991

Origine du pret	Objet	Date de signature	Conditions Taux %	Durée ans	Différé ans	Montant	Non encore préléve	Remboursé	Principal réstant du
CCCE	Réhabilitation OUAGA II	17-6-87	5.0	13	3	30 197 599	30 197 599		0
CCCE	Barrage Kompienga	12-12-84	5.0	20	8	5 000 000 000			5 000 000 000
CCCE	Extension CFP	17-6-87	2.0	30	10	234 124 746	60 691 805		173 432 941
KFW	Barrage Kompienga	1-10-85	5.0	40	10	6 450 000 000			6 450 000 000
BFCI-B	Sous-station Kossodo	27-2-85	13.5	7	2	300 000 000		253 391 403	46 608 597
BOAD	3'e groupe 5 MW, OUAGA II	4-10-78	8.0	15	5	570 000 000		468 000 000	102 000 000
BOAD	Extension 3'e tranche Ouaga II	11-1-81	11.5	13	4	999 987 600		650 000 000	349 987 600
BOAD	Sous-station Kossodo	26-11-85	10.0	12	4	511 760 361		156 250 000	355 510 361
BIB/BICIA	Construction siège social	11-12-84	13.5	7	2	400 000 000		400 000 000	0
Danida 2	Inst. 33 feux. Electr. 6 c.s.	19-1-79	0.0	40	10	777 077 918			777 077 918
Danida 3	Passage en souterrain. Electr. quartiers	22-4-82	0.0	50	10	1 155 809 199			1 155 809 199
CCCE	Interconnexion Ouaga - Koudougou	1-2-90	4.0	20	5	5 150 000 000	1 832 495 326		3 317 504 674
Etat	Extension 3'e tranche Ouaga II		6.0			875 000 000		125 000 000	750 000 000
Etat	Extension CFP		2.0			15 875 254			15 875 254
Etat	Réhabilitation Ouaga II		5.0			319 802 401			319 802 401
BEI	Interconnexion Bobo - Banfora	20-4-89	1.0	10	3	22 823 450			22 823 450
KFW	Centrale Mini-hydraulique Niofila					57 000 000	57 000 000		0
		Total				22 869 458 528	1 980 384 730	2 052 641 403	18 836 432 395

Personnel

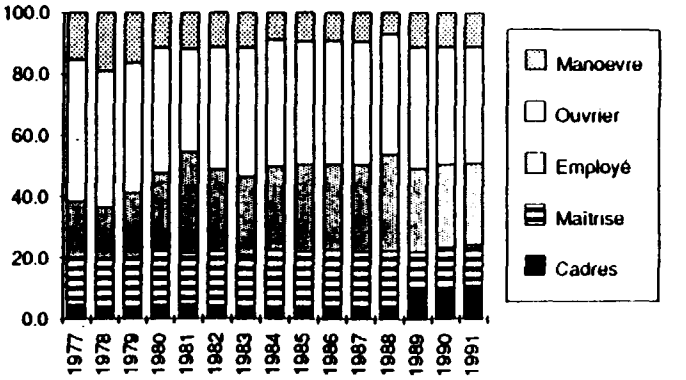
Evolution des effectifs

Annee	Cadre	Maitrise	Employé	Ouvrier	Manoevre	Total
1977	22	70	83	211	72	458
1978	21	77	83	223	96	500
1979	23	89	120	240	94	566
1980	28	100	150	236	68	582
1981	29	101	201	204	73	608
1982	29	117	180	265	78	669
1983	27	123	185	302	84	721
1984	28	142	202	309	68	749
1985	28	141	219	309	75	772
1986	37	160	240	348	82	867
1987	40	174	281	393	95	983
1988	45	184	330	407	74	1040
1989	100	146	305	443	128	1122
1990	124	159	327	459	137	1206
1991	139	161	334	470	140	1244



Evolution de la structure (%)

1977	4.8	15.3	18.1	46.1	15.7	100
1978	4.2	15.4	16.6	44.6	19.2	100
1979	4.1	15.7	21.2	42.4	16.6	100
1980	4.8	17.2	25.8	40.5	11.7	100
1981	4.8	16.6	33.1	33.6	12.0	100
1982	4.3	17.5	26.9	39.6	11.7	100
1983	3.7	17.1	25.7	41.9	11.7	100
1984	3.7	19.0	27.0	41.3	9.1	100
1985	3.6	18.3	28.4	40.0	9.7	100
1986	4.3	18.5	27.7	40.1	9.5	100
1987	4.1	17.7	28.6	40.0	9.7	100
1988	4.3	17.7	31.7	39.1	7.1	100
1989	8.9	13.0	27.2	39.5	11.4	100
1990	10.3	13.2	27.1	38.1	11.4	100
1991	11.2	12.9	26.8	37.8	11.3	100



Annexe II
Tableau 13

Annexe II
Tableau 14

Projections financieres de SONABEL
(millions FCFA)

	1991	1992	1993	1994	1995
Compte d'exploitation					
Produits:					
Ventes d'électricité et location compteurs	14 548	15 140	15 755	16 395	17 062
Travaux remboursables et autres	943	990	1 040	1 092	1 146
Produits hors exploitation	1 018	1 010	1 088	1 428	1 428
Total Produits	16 509	17 140	17 883	18 915	19 636
Charges:					
Achats matières et fournitures	7 524	6 320	5 751	6 269	5 705
Frais de personnel	2 531	2 784	3 063	3 369	3 706
Autres charges, y compris impots					
Frais financiérs	900	1 949	2 191	2 530	2 677
Amortissements	3 478	3 956	4 115	5 299	6 080
Total charges	15 773	16 513	16 963	18 745	19 540
Resultat net de l'exercice	736	627	920	170	96
Tableau emplois et ressources financieres					
Emplois:					
Programme d'investissements	13 422	15 484	14 682	8 020	1 356
Remboursements imprunts	878	715	663	1 553	1 553
Augmentation fonds roulement	306	235	244	254	264
Amortissements dons et reprise/provision	1 018	1 010	1 088	1 428	1 428
Total emplois	15 624	17 444	16 677	11 255	4 601
Ressources:					
Resultat de l'exercice	736	627	920	170	96
Amortissements	3 478	3 956	4 115	5 299	6 080
Marge brute d'autofinancement	4 214	4 583	5 035	5 469	6 176
Emprunts et dons	11 205	13 310	13 403	7 320	1 156
Total ressources	15 419	17 893	18 438	12 789	7 332
Tresorerie nette	- 205	449	1 761	1 534	2 731
Tresorerie cumulée	2 194	2 643	4 404	5 938	8 669

Source: SONABEL juin 1991

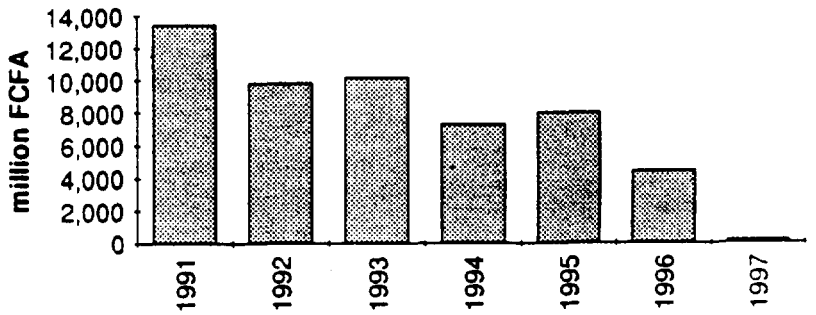
Annexe II
Tableau 15

Programme d'investissement révise *) 1991 - 1997

(En millions de FCFA)		1991	1992	1993	1994	1995	1996	1997
Ghana - Burkina	6,500					3,250	3,250	
Côte d'Ivoire - Burkina	8,800			3,960	3,960	880		
Ouaga - Koudougou	3,000	3,000						
Bobo - Banfora	2,040	1,000	1,040					
Poura - Boromo	368	368						
Koudougou - Perkoa	707			354	354			
Diebougou - Bobo	2,000					1,000	1,000	
Extensions du reseau	1,400	200	200	200	200	200	200	200
Ext Patte d'Oie	300	200	100					
Nouna, Kongoussi	2,710			1,355	1,355			
Niofila (mini-hydro)	2,000		1,000	1,000				
Bagré	12,000	5,520	3,961	2,519				
Renforc. Ouaga I	1,426	1,426						
Centrale Bobo III	4,000	1,000	2,500	500				
Rehab Ouaga II	5	5						
Grp Tract Ouaga I	400		400					
Ouaga III	3,800				1,267	2,533		
Rehab Cellule	297	218	79					
Im SONABEL Bobo	665	200	365	100				
Schema Directeur Informatique	946	285	170	178	157	156		
Total	**53,364**	**13,422**	**9,815**	**10,166**	**7,292**	**8,019**	**4,450**	**200**

**) Revisé en novembre 1992, suite aux discussions de la mission avec la direction de la SONABEL*

Distribution des investissements 1991 - 1997



Annexe II
Tableau 16

SOCIETE NATIONALE D'ELECTRICITE
DU BURKINA (S O N A B E L)
01 BP 54 OUAGADOUGOU 01

DEPARTEMENT COMMERCIAL

TARIFS DE VENTE D'ENERGIE ELECTRIQUE AU BURKINA FASO

EN VIGUEUR A PARTIR DE LA FACTURATION DU MOIS DE JANVIER 1991

		BRANCHEM.	PUISSANCE DISJONC. (A)	AVANCE CONSOM.	FRAIS DE Pose	FRAIS DE liasses timbres	TOTAL	PRIME FIXE MENSUELLE	TARIFS Frs	REDE-VANCE
BASSE TENSION	MONOPHASE 2 FILS	Location	3 A	3 060	578	490	4 128		68	881
		Usage Domestique Particulier et Administrat. 1)	5	5 400	578	490	6 468	1 030	72	265
			10	10 800	578	490	11 868	2 060		265
			15	16 200	578	490	17 268	3 089		265
			20	21 600	578	490	22 668	4 119		444
			25	27 000	578	490	28 068	5 149		444
			30	32 400	578	490	33 468	6 179		444
	TRIPHASE 4 FILS	Usage Domestique Part.& Adm. 1) Force motrice T. monome	5	16 200	1154	490	17 844	3 080	72	712
			10	32 400			34 044	6 160		712
			15	48 600			50 244	9 240		712
			20	64 800			66 444	12 320		797
			25	81 000			82 644	15 400		797
			30	97 200			98 844	18 480		797
		Force Motrice Tarif horaire	Prime fixe par KW souscrit et par an 20 083 F CFA * Heures de pointe 108 F CFA * Heures pleines 57 F CFA							
MOYENNE TENSION		Particuliers & Administrations 1)	ABONNES INDUSTRIELS ET AUTRES Prime fixe par KW souscrit et par an : 44 870 F CFA Heures de pointe 94 F CFA Heures pleines 43 F CFA							4 958

Eclairage Public - Tarif Unique : 100 Francs

OBSERVATIONS

- Redevances des abonnements Moyenne Tension et Basse Tension Tarif horaire
  Location : 3 895 F CFA) Redevance
  Entretien: 1 063 F CFA) 4958 FCFA

- Avance sur consommation Moyenne Tension
  Puissance souscrite (PS) X 100 X 94 = A/C

- Avance sur consommation Basse Tension Tarif Horaire
  Puissance souscrite (PS) X 30 X 108 = A/C

* Heures de pointe

De 10H à 14H et de 16H à 19H

* Heures pleines

De 0H à 10H
De 14H à 16H et de 19H à 24H

1) L'administration est dispensée du versement de l'avance sur consommation.