Japan International Cooperation Agency (JICA)
Ministry of Water, Hydraulic and Rural Equipment (MHEHR)
Agency of Transfer of Rural Equipment (ATER)
The Republic of Senegal

The Study on Regional Rural Development Plan in the Republic of Senegal

Executive Summary

March 2002

JICA Development Study Team
Nippon Development Service Co., Ltd. N

Japan International Cooperation Agency (JICA)
Ministry of Mines, Energy and Hydraulics (MMEH)
Agency of Senegalese Rural Electrification (ASER)
The Republic of Senegal

The Study on Photovoltaic Rural Electrification Plan in the Republic of Senegal

Implementation Plan

March 2002

KRI International Corp.
The Institute of Energy Economics, JAPAN

Currency Exchange Rate

(February 2002)

US$＝¥ 133.74

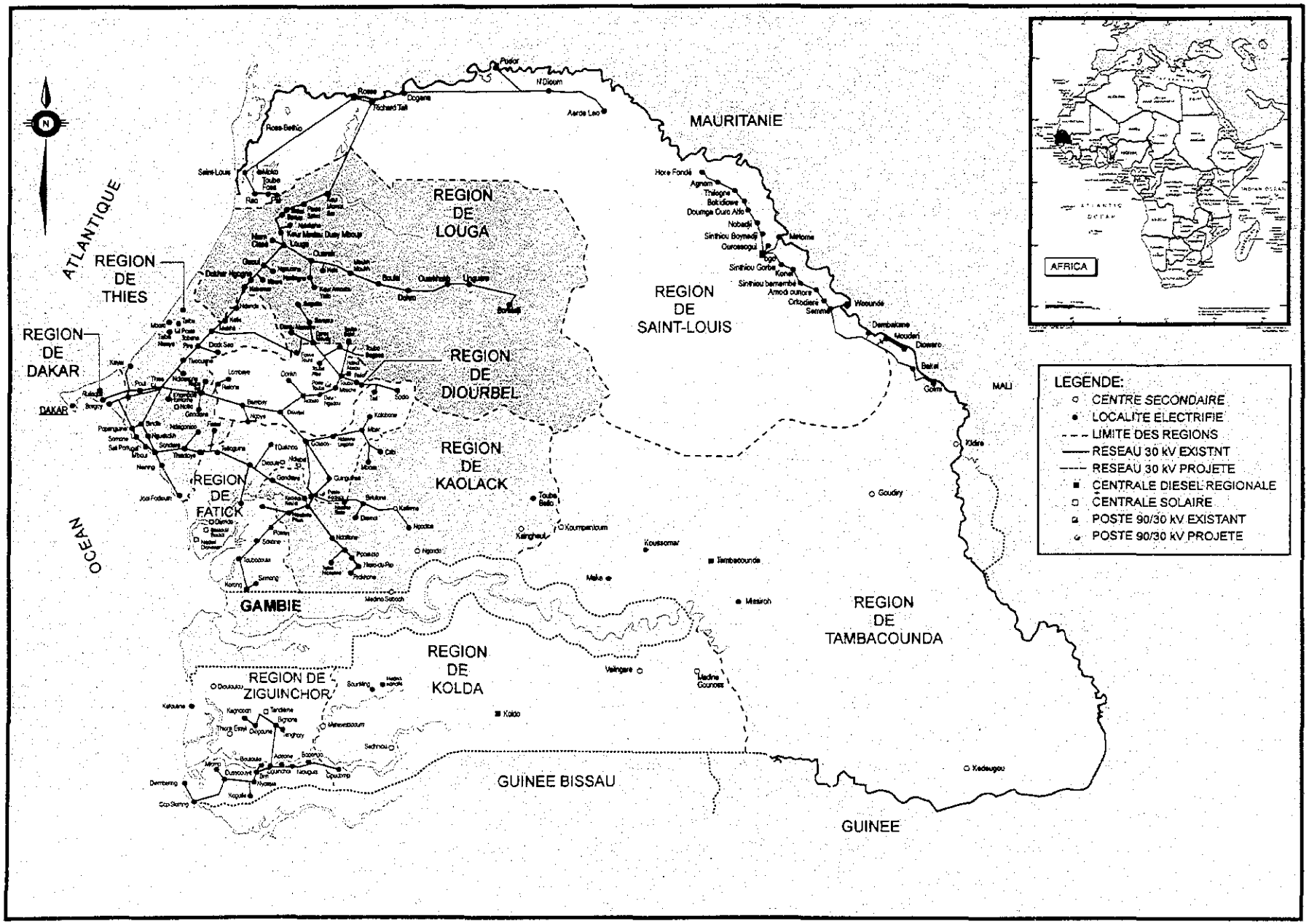
US$＝7.54 FF

Euro＝US$ 0.87

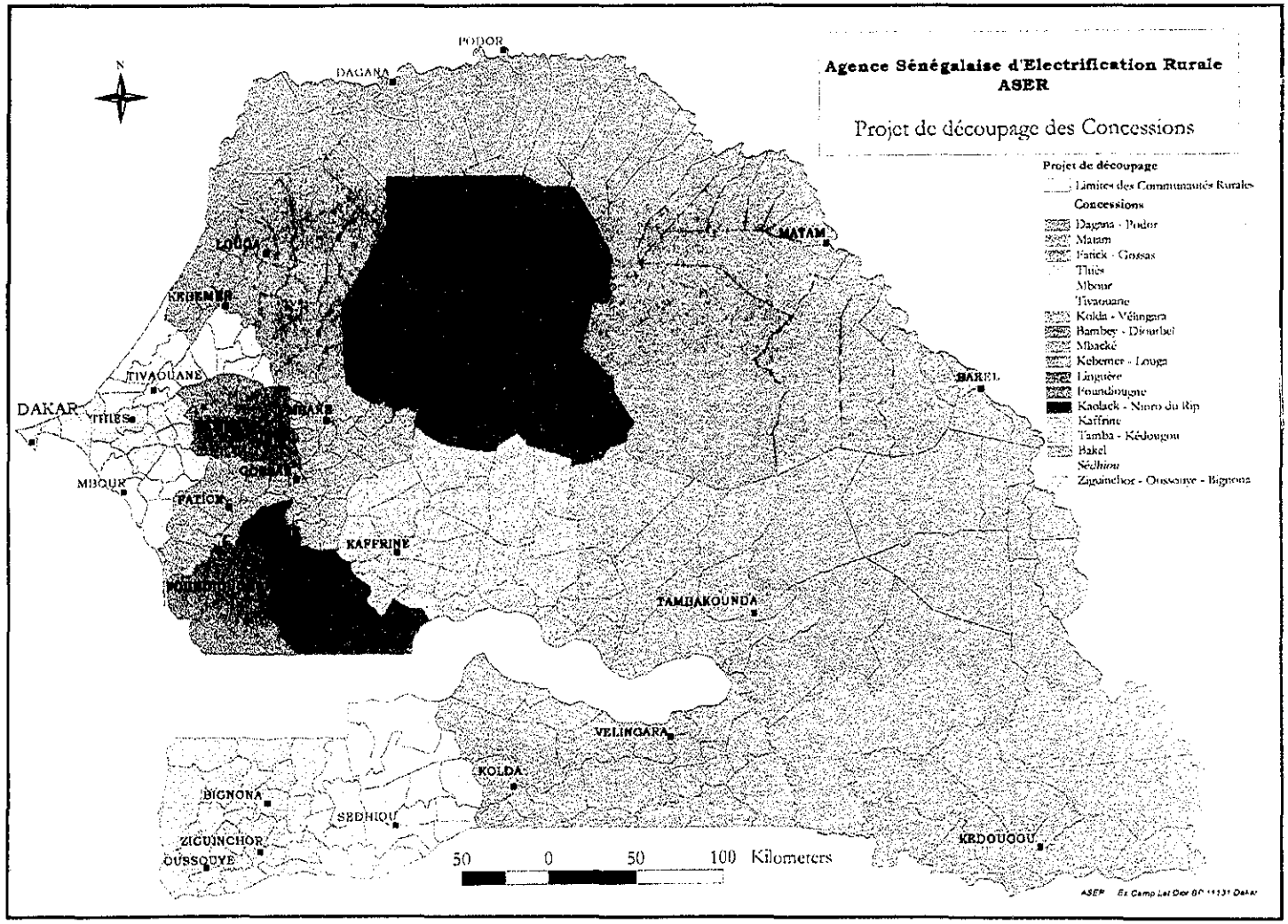
(Euro＝6.56 FF)

FF＝100 CFA (FF: French francs)

CFA＝¥ 0.177



LOCATION MAP



Location of Concession

Location of Concession

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Abbreviation

AC	:	Alternative Current
ADER	:	Association Senegalaise pour le Development de l'Electrification Rurale
ASER	:	Agence Senegalaise d'Electrification Rurale
BCEAO	:	Banque Centrale des Etats de l'Afrique de l'Ouest
CERER	:	Centre d'Etudes et Recherches sur les Energies Renouvelables
		Center of Study and Research on Renewable Energy
CFL	:	Compact Fluorescent Light
CMS	:	Senegalease Mutual Credit Fund
CNCAS	:	Caisse Nationale de Credit Agricole
CNES	:	Confederation Nationale des Employeurs du Senegal
CNQP	:	Centre National de Qualification Professionelle
CR	:	Communaute Rurale
CRSE	:	Commission de Regulation du Secteur de l'Electricite
DAST	:	Scientific and Technical Affairs Delegation
DC	:	Direct Current
DFI	:	Decentralized Financing Institutions
DFS	:	Decentralized Financing Systems
D/G	:	Diesel Generator
ERIL	:	Electrification Rurale d'Initiative Locale
ESCO	:	Energy Service Company
FAO	:	Food and Agriculture Organization
FEM	:	Fonds de l'Environnement Mondial
F/L	:	Fluorescent Light
FOPEN	:	Federation des Organisations pour la promotion des Energies Nouvelles
		Federation of Organization for Promotion of New Energy
GDP	:	Gross Domestic Product
GIS	:	Geographical Information System
GPS	:	Geographical Positioning System
GTZ	:	Deutsche Gesellschaft fur Technische Zusammenarbeit GmbH
HVD	:	High Voltage Disconnection
IDA	:	International Development Agency
IEA	:	International Energy Association
IPP	:	Independent Power Producer
ISN	:	Institute of Senegal National Standard

LV	:	Low Voltage
MMEH	:	Ministere des Mines, de l'Enegie et de l'Hydraulique
NGO	:	Non Governmental Organization
ODA	:	Official Development Assistance
OJT	:	On the Job Training
O&M	:	Operation & Maintenance
PASER	:	Plan d'Action Senegalais d'Electrification Rurale
PCM	:	Project Cycle Management
PDM	:	Project Design Matrix
PLE	:	Plan Locale d'Electrification (LEP)
PPER	:	Programme Prioritaire d'Electrification Rurale
PPMC	:	Pilot Project Management Committee
PTIP	:	Programme Triennal d'Investissements
PV	:	Photovoltaic
RESCO	:	Regional Energy Service Company
ROE	:	Return on Equity
SEMIS	:	Services de l'Energie en Milieu Sahelien
SFD	:	Systemes Financiers Decentralises
SHS	:	Solar Home System
SPF	:	System Photovoltaique familial
UCAD	:	University of Dakar
UNDP	:	United nations Development Program
VUA	:	Village Users Association
WB	:	World Bank
WHO	:	World Health Organization

Unit

mm	:	millimeter
m	:	meter
km	:	kilometer
El.m	:	Elevation in meter
l/s	:	liter per second
m/s	:	meter per second
m^3/s	:	cubic meter per second
mm^2	:	square millimeter

km^2	:	square kilometer
mg	:	milligram
ton, t	:	metric ton
V	:	Volt
W	:	Watt
kW	:	kilowatt
MW	:	Megawatt
Wp	:	Watt peak
kWp	:	kilowatt peak
GWh	:	Gigawatt hour
kWh	:	Kilowatt hour
MVA	:	Megavolt ampere
KVA	:	Kilovolt ampere
Ah	:	ampere hour
Hz	:	Hertz
RPM	:	Revolution (revs) per minute
%	:	Percentage

Currency Unit

CFA	:	Senegalese Currency
US$	:	US Dollar
M.US$	:	Million US Dollar
Euro	:	European Currency
Yen	:	Japanese Currency

CHAPTER 1 SOCIO ECONOMIC CONTEXT OF SENEGAL

1.1 Macro-economy

(1) Economic Performance

Senegal is a low-income country with a population of about 9 million and GDP of CFA2,761 billion at current price as of 1998, and hence GDP per capita (CFA 306,800 equivalent to US$520 using average exchange rate of US$1=CFA 590) in 1998. Economic performance of Senegal in 1990s indicated by GDP as final demand (expenditure) at the 1987 constant price is shown in Table 1.1.

Table 1.1 GDP as Final Demand in 1990s (1987 constant price)

unit: Billion CFA

	1990	1993	1994	1996	1998 (*)	Annual Average Growth Rate (%) 90-93	94-98
Consumption	1,370.6	1,375.5	1,328.3	1,472.4	1,685.0	0.1	6.1
Investment	198.3	193.7	168.9	289.2	312.7	-0.7	16.6
Expenditure	179.9	187.2	199.6	236.4	312.7		
Stock variation	18.4	6.5	-30.7	52.8	-		
Export	379.2	345.4	416.2	405.4	424.1	-3.2	0.5
Import	460.6	433.7	390.0	482.4	551.9	-2.0	9.1
GDP	1,487.5	1,481.0	1,523.4	1,684.6	1,869.9	-0.1	5.3

Source: Situation Economique et Social du Senegal 1998
Remark: (*) estimated Figures

Economic performance in the early 1990s was characterized by negative growth of GDP caused by high tariffs and subsidies associated with demand control policy internally, and EEC recession externally. Until 1993, Senegal kept a fixed exchange regime, but because of a gradual diversification of trading partners (African and Asian countries) and the depreciation of the currencies of the major trading partners, a fixed exchange regime was no longer a useful tool to protect the country. The devaluation and the program of structural reforms initiated in 1994 reversed the negative trend in GDP and investment. Between 1994 and 1998 annual average growth rate of GDP turned positive remarkably from –0.1% to 5.3%. Economy is broadly classified into household, public and private entities. Both consumption and investment are disaggregated by entity to see economic performance of them, shown in Table 1.2.

Table 1.2 Economic Performance of Entities in 1990s (1987 constant price)

unit: Billion CFA

	1990	1993	1994	1996	1998 (*)	Annual Average Growth Rate (%) 90-93	94-98
Consumption	1,370.6	1,375.5	1,328.3	1,472.4	1,685.0		
Household	1,146.1	1,161.3	1,126.2	1,263.2	1,464.6	0.4	6.8
Public	224.5	214.2	202.1	209.2	220.4	-1.6	2.2
Investment	179.9	187.2	199.6	236.4	312.7		
Household	28.1	29.9	30.5	31.8	34.8	2.1	3.4
Public	55.9	51.7	44.9	86.2	104.1	-2.6	23.4
Private	95.9	105.6	124.2	118.4	173.8	3.3	8.8

Source: *Situation Economique et Sociale du Senegal 1998*
Remarks: Investment accounts for only expenditure

The consumption spending of household sector turned much more active from annual average growth rate of 0.4% during 1990-1993 to 6.8% between 1994 and 1998, while the authorities of public sector maintained strict restraints on spending, particularly on public sector wages, accordingly annual growth of public sector's consumption was marginal, just 2.2% between 1994 and 1998.

Public investment was once contracted at the initiation (1994) of the structural reform, but grew tremendously 1994 onwards, 23.4% per annum between 1994 and 1998. This was due to the continuous inflow of grants and concessional loans. The official assistance on the flow basis in the former 1990s is shown in Table 1.3.

Table 1.3 Official Assistance Flow

unit: US$ million

	1990	1991	1992	1993	1994	1995
Grants	552.9	347.3	331.1	299.4	476.4	370.6
Loans	95.8	59.5	248.4	100.3	18.5	48.0
Total	648.7	406.8	579.5	399.7	494.9	418.6

Source: World Bank Debtor Reporting System

The year of 1993 marked a contraction of official flow, but such a flow turned to increasing trend in 1994 onwards. Grants constituted high ratio of official assistance (i.e.88% in 1995).

Private investment gives a good signal to the economy of Senegal, which might indicate the correlation between rising trend of private investment and trade liberalization. The

devaluation benefited the export business of ground nut products, fresh fish, phosphate and cotton, and reduced domestic purchasing power towards imports goods, resulting in encouragement of entry of domestic small firms in import-competing sector.

The major export commodities such as ground nuts and products, and fresh fish are significant partly because of their contribution to foreign exchange earning and partly because they are the primal income sources of farmers and fisher folk who are the major users of rural electrification. The effect of the devaluation to export of primary and processed products was not substantial since export performance of such commodities were constrained by exogenous factors such as international markets and competitors' strength. In the long run, annual average growth rate of export after the devaluation turned out to be just marginal, 0.5% between 1994 and 1998.

Although the devaluation resulted in price hike of imported goods, import continued to grow at the relatively high rate, 9.1% per annum between 1994 and 1998. Imported goods consisting of intermediate and capital goods (i.e. photovoltaic equipments) can not easily substituted with domestic inputs. The devaluation, therefore, did not always help in import substitution, while increasing the cost of imported inputs.

(2) Economic Structure

Economic structure indicated by sectoral contribution to GDP and labor force is shown in Table 1.4.

Table 1.4 Economic Structure

	Sectoral Share of GDP				Labor Force
	1990		1998		1990
	Value	Share	Value	Share	Share
Primary	318.2	(21.4)	325.8	(17.4)	76.7
Secondary	277.1	(18.6)	376.9	(20.2)	7.5
Tertiary	892.2	(60.0)	1,167.2	(62.4)	15.8
GDP	1,487.5	(100.0)	1,869.9	(100.0)	100.0

Source: Situation Economique et Sociale du Senegal 1998
ILO Labor Force Data
Remarks: GDP value is expressed by CFA billion at 1987 constant price.

Structural change of GDP between 1990 and 1998 shows the gradual decline in GDP share in the primary sector and the rise of GDP share in the secondary and tertiary sectors. The primary sector contributes to 21.4 percent in 1990, but its contribution drops down to

17.4 percent in 1998. The GDP share of other sectors increased by 2 percent between 1990 and 1998.

The unbalanced structure of the primary sector can be observed by its contribution to 75 percent of labor force and only GDP share of 21 percent. Whereas the tertiary sector gains 60 percent of GDP with only labor force of 15.8 percent. This implies that income distribution is much less equal.

Agriculture accounts for 8 percent of GDP and is still the leading sub-sector of the primary industry, but its performance shows the decline in trend, depending on rainfall and world price. The main crops are groundnut and cotton, with more than half of production exported. The other crops such as rice, maize and sorghum are for domestic consumption. Agriculture as income source has been erratic and unstable for farmers dominant in rural area. Fishing is the major export industry but accounts for 2 percent of GDP only.

Manufacturing accounting for 13 percent of GDP is the leading sub-sector of the secondary industry and has gradually grown in 1990s. The manufacturing sector is still poorly structured including fish canning, oilseed processing, phosphate chemicals, textiles and light industry.

The tertiary sector accounting for 62 percent of GDP is roughly disaggregated into public service (transportation and telecommunication) and private business (commerce, retail and banking etc) contributing to about 80 percent of the value added in the tertiary sector.

1.2 Administrative Structure and Demography

(1) Administrative Structure

Senegal is administratively composed of the following structure:

- 10 Regions
- 30 Departments (Prefecture)
- 90 Arrondissements (Sub-Prefecture)
- 37 Communes
- 317 Communauté rurale (community rural)

- 13,566 villages

The region-wise breakdown of administrative units based on 1998 census is shown in Table 1.5.

Table 1.5 Region-wise Breakdown of Administrative Units

Region	Department	Arrondissment	Commune	Community Rural	Village
Dakar	3	-	3	2	335
Thies	3	10	6	31	1,577
Diourbel	3	7	3	32	1,172
Saint-Louis	3	11	5	28	881
Kaolack	3	10	3	41	1,992
Tambacounda	3	12	3	32	1,468
Ziguinchor	3	8	3	25	502
Kolda	3	11	3	43	2,202
Louga	3	11	3	48	2,507
Fatick	3	10	5	35	930
Total	30	90	37	317	13,566

Commune on which the term "urban" is based concentrates on Dakar region and regional cities. A "community rural" is a composition of villages which are the smallest unit in rural areas. The average number of villages constituting a community rural is estimated to be 42 on the national average.

The hierarchy of administration for rural development implemented by the Ministry of Interior is illustrated in Figure. 1.1.

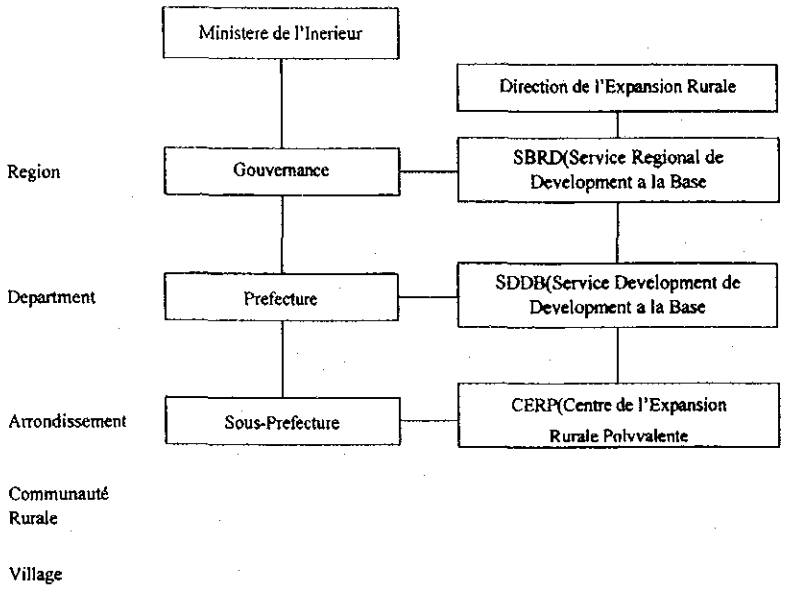


Figure 1.1 Organizational Chart of MOI by Administrative Level

CERP implementing a grassroot-based plan of rural development consists of a chief officer, a rural development officer and other officers dispatched from line agencies. A planning base of rural development is put on community rural.

(2) Population

The nationwide population was 6,912,571 in the census year of 1988 and was estimated to be 9,521,000 in 2000 (Direction de la Prévision et de la Statistique). The whole population of Senegal by region in 1998 and 2000 is shown in Table 1.6.

Table 1.6. Population by Region in 1988 and 2000

Region	1988	2000	Annual average growth rate (%)
Dakar	1,492,344	2,326,000	3.70
Zicuinchor	399,248	543,000	2.59
Diourbel	620,660	902,000	3.16
Saint-Louis	661,791	842,000	2.03
Tamba	386,864	518,000	2.46
Kaolack	813,112	1,100,000	2.55
Thies	943,302	1,310,000	2.77
Louga	491,197	555,000	1.02
Fatick	510,867	628,000	1.73
Kolda	593,186	797,000	2.49
Total	6,912,571	9,521,000	2.70

Source: Population du Senegal DPS

Annual average growth rate of the whole population between 1988 and 2000 is calculated to be 2.70 percent. Annual average growth rate of population is more than the national average in three regions. In particular, that of the Dakar region is estimated to be 3.77 percent, the highest growth rates. Accordingly the population ration by Dakar region increased from 21.5% in 1988 to 24.4% in 2000.

The Senegal Statistical Office (DPS) surveyed population (4,772,400) of more than 10 years old and identified that 19% of them or 897,600 persons migrated from places of origin to those of destination in 1991. The migration of 897,600 persons from places of origin to those of destination is shown in Table 1.7.

Table 1.7 Migration of Origin and Destination

Destination / Origin	External (Abroad)	Internal		Total
		Dakar	Others	
Dakar	61,899	-	60,349	122,248
Others	107,463	340,888	326,989	775,340
Total	169,362	340,888	387,338	897,588

Source: Dimensions Sociales de l'Ajustement

As far as destination is concerned, external and internal migration constituted 19% and 51% respectively. Out of internal migration, 340,888 or 47% migrated from other regions to Dakar. Urban concentration of internal migration in Dakar was substantial, which implies the higher population growth rate in Dakar than in other regions observed in Table 1.6. As to origin, other regions constituted 86% of total figure migrated.

1.3 Socio-economy in Rural Area

(1) Population and Household

A community rural is perhaps an appropriate level of administration to comprehend the distribution of household and population in rural area. The average number of household and population per community rural by region based on the 1988 census is shown in Table 1.8.

Table 1.8 Household and Population per Community Rural

Region	Nos of CR	Population	Household	Ave of population per CR	Ave of household per CR
Dakar	2	54,207	6,374	27,100	3,190
Thies	31	617,530	62,284	19,920	2,010
Diourbel	32	487,828	54,523	15,240	1,700
Saint-Louis	28	479,584	56,523	17,120	2,030
Kaolack	41	626,100	61,673	15,270	1,500
Tambacounda	32	322,512	34,583	10,080	1,080
Ziguinchor	25	247,698	33,506	9,910	1,340
Kolda	43	531,582	52,361	12,360	1,220
Louga	48	437,571	46,446	9,120	970
Fatick	35	455,153	48,534	13,000	1,390
Total	317	4,259,765	457,120	13,440	1,440

Source: 1988 Census

The population (4,259,765) in rural area corresponds to 61 percent of the whole population in 1988. On the national average, a community rural consists of 42 villages (calculated in Table 1.5) with households of 1,440 and population of 13,440. The average number of households per community rural is in the range from the lowest of 970 in Louga to the highest of 3,190 in Dakar and that of population from 9,120 to 27,100.

In Senegal, a typical village is formed by a collection of concessions (settlement block encroached by the wall) in which several households of the same family dwell collectively. At the time of the previous national census (1988), a village consists of 33 households on the national average, based on rural households of 457,120 and villages of 13,566.

At present, the number of villages is reported to be 13,230 nationwide. The breakdown of villages by village population size is shown in Table 1.9 for both electrified and non-electrified villages.

Table 1.9 Distribution of Villages by Population Range

	P<500	500<P<1,000	1,000<P<2,000	P>2,000	Total
Electrified	197	73	82	716	528
Non-electrified	10,188	1,724	646	144	12,702
Whole	10,385	1,797	728	320	13,230

Source: SEMIS (Local Consultant Company)

About 78 percent or 10,385 villages is those with population of less than 500. Villages having population of more than 2,000 accounts for 2 percent only. The number of electrified villages is reported to be 528 representing only 4% of the whole villages. The

distribution of electrified villages by population range turns out to be 37% or 197 for (P<500) and 14% or 73 for (500<P<1,000). The reasons why small villages with population of less than 1,000 were electrified are electricity uses for industry and social services rather than domestic use. Non-electrified villages are still substantial, representing 96% of the whole villages. Out of non-electrified villages, about 80 percent or 10,188 villages is those with population of less than 500.

(2) Income Distribution and Sources of Rural Households

The nationwide socioeconomic survey was conducted as a component of the JICA Study in order to provide the fundamental information with the Implementation Plan on PV Rural Electrification. The survey was carried out towards 80 villages scattered over 9 regions, covering about 1,670 village households, of which 1,545 responded to the questionnaire sheet about annual income. The percentage distribution of respondents by income class is shown in Table 1.10.

Table 1.10 Percentage Income Distribution of Rural Households

Unit: %

Region	Annual Income Bracket (unit: CFA 1,000)								
	<300	300~600	600~800	800~1,000	1,000~2,000	2,000~3,000	>3,000	Total	Nos of respondents
Diourbel	39.8	10.7	32.1	7.7	2.6	6.6	0.5	100.0	196
Fatick	40.3	9.7	25.0	9.7	6.3	4.5	4.5	100.0	176
Kaolack	27.8	12.3	32.6	8.6	11.2	5.3	2.2	100.0	187
Kolda	30.6	3.2	26.3	10.8	10.8	14.0	4.3	100.0	186
Louga	15.2	5.8	27.5	16.4	14.6	18.7	1.8	100.0	171
Saint-Louis	14.1	1.5	32.6	17.0	12.6	16.3	5.9	100.0	135
Tambacounda	17.2	2.0	22.2	12.6	15.2	25.3	5.5	100.0	198
Thies	50.0	7.4	26.7	10.2	1.7	4.0	0.0	100.0	176
Ziguinchor	58.3	3.3	30.0	3.3	1.8	3.3	0.0	100.0	120
Whole country	32.0	6.5	28.2	10.7	8.7	11.1	2.8	100.0	1,545

Source: Nationwide Socioeconomic Survey (JICA Study)

Suppose that income bracket is classified into four (4) categories, I) low income (<600), ii) middle income (600~1,000), iii) high middle income (1,000~2,000), and iv) high income (>2,000), income distribution of four (4) brackets for the whole country turns out to be 38.5% for low income, 38.9% for middle income, 8.7% for high-middle income and 13.9% for high income. Income distribution by region is quite different and is largely divided into two groups. One is a group of regions where income distribution is skewed to low income class, represented by Diourbel, Fatick, Thies and Ziguinchor. The other is a group of regions where income distribution to high-middle and high income brackets is

more than that of the whole country, represented by Saint-Louis and Tambacounda particularly.

Income distribution of rural households (respondents) is further disaggregated into those by village population size, as shown in Table 1.11.

Table 1.11 Distribution of Rural Household Income by Village Population

(unit: %)

Village Population Size	Annual Income Bracket (unit: CFA 1,000)								
	<300	300~600	600~800	800~1,000	1,000~2,000	2,000~3,000	>3,000	Total	Nos of respondents
P<500	30.3	6.1	30.5	12.4	8.1	11.0	1.6	100.0	643
500<P<2,000	30.5	6.6	28.6	10.4	8.9	11.7	3.3	100.0	695
P>2,000	42.5	7.2	19.3	6.8	9.7	9.7	4.8	100.0	207
Whole country	32.0	6.5	28.2	10.7	8.7	11.1	2.8	100.0	1,545

Source: Nationwide Socioeconomic Survey

The distribution of income bracket from middle to high income accounts for 33.1 percent in the category of village population (P<500), 34.3 percent (500<P<2,000) and 31.0 percent (P>2,000). The similar pattern of income distribution for three categories implicitly indicates that connection rates to rural electrification would be identical in any village irrespective of village population size.

Though the data is fairly old, the Senegal Statistical Office conducted household survey of revenue source for both urban and rural areas in 1991. The breakdown of revenue sources indicated by percentage is shown in Table 1.12.

Table 1.12 Household Revenue by Source

(unit: %)

Sources	Rural	Urban
Agriculture	22.0	0.6
Groundnuts	(13.2)	
Vegetable	(3.2)	
Cotton	(1.6)	
Rice	(1.0)	
Others	(3.0)	
Cottage industry	39.0	30.4
Public employment	4.3	22.4
Private employment	8.7	26.6
Transfer money	3.4	7.4
Others	22.6	12.6
Total	100.0	100.0

Source: Dimensions Sociales de l'Ajustement (1992)

Income structure of rural households indicates that agriculture was no longer the significant income source, representing only 22 percent as share. Groundnuts as the major export commodity were dominant as the principal income source, followed by vegetable, cotton and rice. Cottage industry, to be surprised, contributed to 39 percent of rural household income. Money transferred from families migrated to urban areas shared 3.4 percent of total income. The higher percentage of income distribution to high-middle and high income classes in Saint-Louis and Tambacounda, as shown in Table 1.10 is perhaps ascribed to income transfer from migrants to overseas countries in Dagana-Podor (Saint-Louis) and Bakel (Tambacounda region). The top three regions earning major income from crop production and cottage industry are shown in Table 1.13.

Table 1.13 Top Three Regions Earning Major Incomes

	1st	2nd	3rd
Groundnuts	Kaolack	Fatick	Kolda
Vegetables	Dakar	Thies	Saint-Louis
Cotton	Kolda	Tamba	
Rice	St-Louis	Tamba	Kaolack
Cottage industry	Thies	St-Louis	Kaolack

Source: Dimensions Sociale de l'Ajustement

Kaolack is ranked as the largest production area of groundnuts. Saint Louis is featured by rice and vegetable. Cotton production concentrates on Kolda and Tamba. Both Thies and Saint Louis are characterized by activities of household industries.

(3) Rural Household Expenditures

Expenditure is an indication measuring purchasing power of a rural household. The monthly household expenditures of 1,339 respondents were surveyed through the nationwide socioeconomic survey of the JICA Study. The average monthly expenditure per household is estimated by annual income bracket, as shown in Table 1.14.

Table 1.14 The Average Monthly Expenditure per Household

Unit: CFA

Categories	Annual Income Brackets (unit: 1,000 CFA)						
	<300	300-600	600-800	800-1,000	1,000-2,000	2,000-3,000	>3,000
Food	29,995	41,473	54,937	71,537	73,915	88,889	160,236
Non-food	42,647	54,879	72,265	82,936	105,440	141,983	187,485
Energy	2,151	2,830	4,072	4,674	6,213	5,907	8,671
Total	74,793	99,182	131,274	159,147	185,568	236,779	356,392

Source: Nationwide Socioeconomic Survey (JICA Study)
Remarks: Non-food consists of tea, cloth, health, education and water change. Energy consists of paraffin, dry cell for torch lamp, dry cell for radio, dry cell for radio-cassette, candle, gas and battery charge.

First of all, it can be observed that purchasing power of a rural household is dynamic, exceeding over income. Excessive expenditure would be ascribed partly to the large number of family members and partly to village loan or fresh money borrowed from relatives. Secondly non-food is identified to be the largest expenditure items consisting of cloth, health, education and water charge. Energy expenditures are segregated from others in order to analyse the average purchasing power of a rural household for energy consumption by income bracket. The average monthly energy expenditure turns out to be about 2,150 CFA at the lowest and 8,700 CFA at the highest. Five thousands (5,000) CFA is the approximate mean value as the monthly energy expenditure per household. This value is interpositioned in annual income brackets between 800~1,000 and 1,000~2,000 thousand CFA.

Energy expenditures are further disaggregated into respective consumption items, as shown in Table 1.15. It should be noted that the figures shown as below are the average amount of expenditures for the respective item (total sum of expenditure divided by the number of the questionnaire respondents), are not equal to the energy expenditure (total sum of energy expenditures divided by the questionnaire respondents) as shown on Table 1.14.

Table 1.15 The Average Monthly Energy Expenditures by Items

Unit: CFA

Energy Expenditures	Annual Income Brackets (unit: 1,000 CFA)						
	<300	300~600	600~800	800~1,000	1,000~2,000	2,000~3,000	>3,000
Paraffin	899	938	1,255	1,276	1,434	1,760	2,077
Dry cell for torch lamp	82	99	143	176	190	224	294
Dry cell for radio	636	809	952	1,081	940	1,119	1,547
Dry cell for radio-cassette	1,602	1,863	2,390	2,824	4,113	3,594	5,152
Candle	861	951	869	1,494	1,764	846	597
Gas	1,479	1,964	1,408	1,375	1,981	3,000	2,188
Battery	2,396	2,361	2,282	2,631	3,036	2,482	2,871

Source: Nationwide Socioeconomic Survey (JICA Study)

Paraffin (Kerosene) and dry cell for torch lamp are expenditures for lighting purpose. The higher annual income is, the more the expenditure for lighting is. This implies that energy consumption for lighting increases in proportion to increase of income. On the other hand, it will be recognized that the expenditures for the battery as power source used for TV or radio-cassette, and for dry cell for radio-cassette have reached some reasonable level of amount, which might be irrespective of income level. This implies that demand for informations disseminated from mass media is quite high among village people.

The relative comparison of the average monthly energy expenditure per household is made by region where the national average is supposed to be 100%.

Table 1.16 Relative Comparison of Energy Expenditure per household by region and income class (nation average = 100)

Unit: %

Regions	Annual Income Brackets (unit: 1,000 CFA)						
	<300	300~600	600~800	800~1,000	1,000~2,000	2,000~3,000	>3,000
Diourbel	68	73	47	40	47	53	78
Fatick	74	63	55	57	28	72	39
Kaolack	69	73	68	37	57	43	26
Kolda	140	140	126	101	115	204	85
Louga	143	133	118	126	70	87	133
Saint Louis	126	112	102	132	107	99	72
Tambacounda	155	168	160	136	147	158	139
Thies	83	97	73	65	70	-	-
Ziguinchor	119	107	83	-	83	-	-

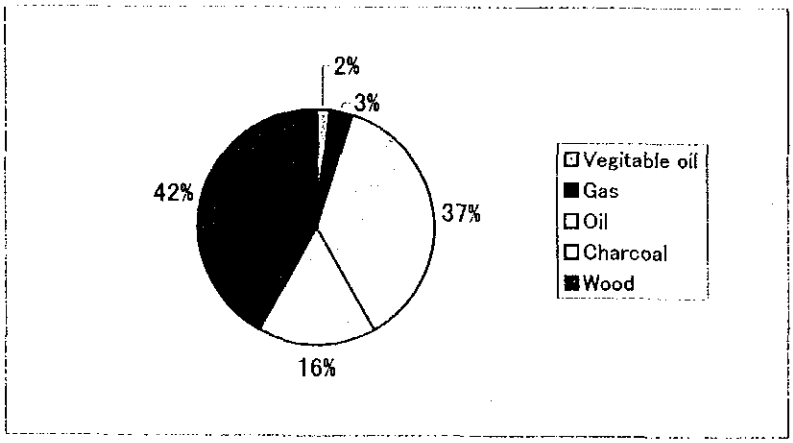
Source: Nationwide Socioeconomic Survey (JICA Study)

Nine (9) regions can be largely classified into two groups in terms of the purchasing power of a rural household for energy consumption. One is the regions' group represented by Kolda. Louga, Saint Louis and Tambacounda where the purchasing power of a rural household for energy consumption is almost higher than the national average, which is particularly envisaged in income brackets of low, middle and high-middle. The other is a group represented by Diourbel, Fatick, Kolda and Thies where the purchasing power of a rural household for energy consumption is lower than the national average for all income brackets.

1.4 Energy Sector

(1) Energy source

The sources of energy demand in Senegal consist of wood (42%), charcoal (16%), oil (37%), gas (3%) and vegetable waste (2%).



Remarks: The composition of energy sources is referred to "Energy in Senegal" March, 1995 Ministry of Energy

Figure 1.2 Composition of Energy Source

Wood is widely used for household energy use such as cooking, boiling, and household industry; etc. Nevertheless a heavy dependence on wood and wood products as energy source led to negative environmental effects such as reduction of arable land and over-exploitation of natural forestry reserve.

The country is still dependent on imported oil used in transportation, industry and power generation. The payment of import oil accounted for 16 percent of total export revenues. Though the oil refinery industry was helped by a favorable condition of international price of oil, the devaluation initiated in 1994 caused push-up of C.I.F price of imported oil. The devaluation made the oil-consuming power industry (SENELEC) less competitive compared to other countries in terms of the cost of electricity. International comparison of the electricity cost in 1995-96 is shown in Table 1.17

Table 1.17 International Comparison of Electricity Cost

	Côte-d'Ivoire	Senegal	Indonesia	Malaysia	Thailand
US $/kWh	0.07	0.11	0.076	0.062	0.07

Source: The Challenge of International Integration, World Bank 1997

The electricity cost of the power industry in Senegal was US$0.11 per kWh, which was higher than that of Cote d'Ivoire and South East Asian countries.

Kerosene (by-products of crude oil) is still a major source of energy for household lighning in Senegal. The composition (rate) of energy source for lighting in rural and urban area is shown in Table 1.18.

Table 1.18 Energy Source of Household Lighting

Sources	Rural	Urban
Wood	13.9. %	0.2 %
Kerosene	80.0 %	30.3 %
Electricity	2.6 %	58.3 %
Charcoal	2.3 %	11.0 %
Others	1.1 %	0.2 %

Source: Dimensions Socials de l'Ajustement in 1991

Kerosene is dominant as energy source of lighting in rural area, representing that 80% of rural household was dependent on kerosene. Even in urban area, 30% of household use kerosene for lightning

To ease a heavy dependence on wood and import oil, Senegal gave an empetus on exploitation of domestic oil and natural gas in oil-gas field offshore. More importantly Senegal has tried to diversify energy resources, in particular attaching importance to renewable energy.

(2) Renewable Energy

Senegal having its land area of about 200,000km² is topographically featured by extensive lowland with dry sand and soil, and the Senegal River meandering along national boundary with Mauritania and Mali, and the Gambia River penetrating into the country of Gambia and the region of Tambacounda. Senegal is meteorologically characterized by scarce rainfall with the average rainfall of 400mm in the north and 600mm in the south, and endowed with solar energy and wind power.

1) Hydro Potential

The dam development of hydropower with installed capacity of 200,000 kW was planned in the up-stream of the Senegal river. Hydropower is scheduled to be transmitted to three countries. The dam called Manantali is expected to generate 280GWh (compared to a national electricity consumption of 900 GWh per year) and would let SENELEC save 150,000 tons of fuel per year against an actual yearly consumption of 300,000tons. However, potentiality of micro-hydro would be less expected because sufficient head to generate power can not be physically captured due to flat land.

2) Wind Power

Wind energy can be utilized on the coastal fringe where the wind speed is between 2 and 5m per second. But the average speed of 5m per second is not strong enough to sustain wind power generation.

3) Solar Energy

Solar endowed with the yearly sunshine of 3,000 hours and irradiation of 6kWh/ m²/day is regarded as the most promising source of renewable energy. The seasonal variation of irradiation at the four(4) sites is shown in Figure.1.3.

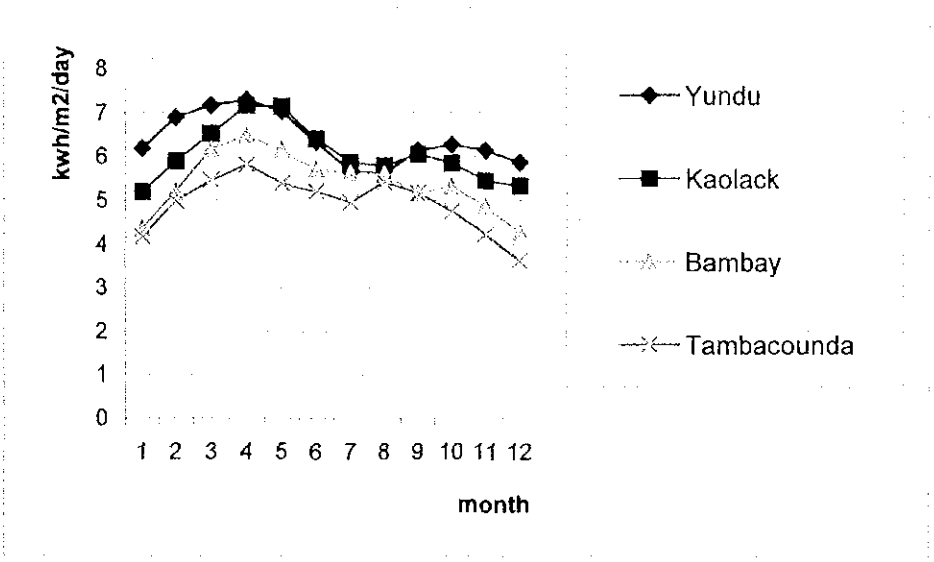


Figure 1.3 Seasonal Variation of Irradiation at 4 Sites

The irradiation (kWh/m²/day) recorded at the four (4) meteorological observation sites is at the peak on April and the lowest on August in the midst of rainy season. The irradiation of 4kWh/m²/day can be exploited at the minimum through the season. Solar Home System(SHS) with a capacity of 50W generates 250Wh (50W × 5 kWh/day) provided that the irradiation is supposed to be 5 kWh/m²/day. This could afford daily electricity consumption of lighting (200~250Wh) of a rural household.

1.5 Public Investment on Electrification

(1) Budget Context

The Consolidated Budget and Investment Plan of the Year 2000 was issued by the Ministry of Economic and Financial Plan on October 1999. The overall fiscal revenue and expenditure in the year of 2000 is summarized in Table 1.19.

Table 1.19 Fiscal Plan of 2000

Current account	Unit : CFA Million
Internal revenue	516,600
Current expenditure	321,800
Balance	194,800
Capital account	
From balance of current account	95,905
Expenditure	341,631
Deficit	-245,726
Deficit finance	245,726
External loan	145,832
External grant	99,894

Source: Budget Consolide d'Investissement

The balance of current account is CFA 194,800 million, out of which CFA95,905 million is transferred to capital account. Capital expenditure accounts for CFA341,631 million, resulting in fiscal deficit of CFA245,726 million. Fiscal deficit is to be financed by external loan (CFA145,832 million) and external grant (CFA99,894 million). Fiscal dependence on external financial resource in terms of capital expenditure is 72 percent.

The development plan of energy sector proposed in the capital account of the 2000 fiscal plan as shown in Table 1.20

Table 1.20 Fiscal Plan of Energy Sector Projects

unit: CFA million

Energy sector Projects	Finance Sources			
	Internal	E loan	E.grant	Total
Rural and Urban Elect.	2,000	0	0	2,000
Programe Energy II	400	3,400	0	3,800
Traditional Energy Management	60	750	1,078	1,888
Manatari Hydropower	0	14,102	11,100	25,202
Others	850	0	0	850
Total	3,310	18,252	12,178	33,740

Source: Budget Consolide d'Investissement Gestion 2000

Energy projects account for CFA33,740 million or 9.9 percent of capital expenditure. About 90 percent of the energy projects are financed by external resources consisting of loan and grant. But conventional electrification project (grid extension) accounts for only CFA2,000million or 5.9% of capital expenditure on energy sector. This implies phase-out of public-oriented electrification project because SENELEC was already privatized, leaving conventional electrification to the company policy plan of SENELEC.

(2) Past Performance of SENELEC

SENELEC used to be the sole state-owned power company responsible for generation, transmission and distribution. The existing network of HV and MV lines as of 2000 is shown in Figure 1.4. The HV line of 90KV is extended from Dakar to Sakal while MV lines of 30KV are spread into regional communes and villages through HV/MV substations or MV/LV substations. Historical records of grid extension 1990 through 1995 are summarized in Table 1.21.

Table 1.21 Historical Records of Grid Extension

unit: km

Year	High voltage	Medium voltage	Low voltage	Total
1990	206	3,067	2,910	6,183
1994	295	3,158	3,590	7,043
1995	295	3,677	3,849	7,821
1998	357	3,924	4,181	8,462
90-98	151	857	1,271	2,275
Per year	19	107	159	284

Source: SENELEC
Remarks: the column of 90-98 indicates grid extension (km)1990 through1998. The column of per year indicates annual average extension (km).

SENELEC implemented grid extension of 2,275km during 1990-1998, consisting of HV (151 km), MV (857 km) and LV (1,271 km). Annual average of extension was 19 km for HV, 107 km for MV and 159 km for LV. The costs of extension is estimated based on unit cost data presented in (Plan Directeur d'Electrification Urbaine et Rurale, Volume1, SNC LAVALIN International). Installation of a substation of MV/LV is assumed to be necessary by one km of MV line extension. The costs of grid extension per year are estimated in Table 1.22.

Table 1.22 Estimation of Grid Extension Costs

Description	MV	LV	Total
Extension (km)	107	159	
No of sub-stations	122	-	
Cost per km (US $)	28,100	16,995	
Cost of a sub-station (US $)	12,150	-	
Total cost (US $ million)	4.5	2.7	7.2

Extension cost of US$7.2 million is almost equivalent to CFA4,824 million using the current exchange rate (US$1=CFA670). In other words, annual average extension cost of MV and LV lines 1990 through 1998 is valued at CFA4,824 million at current price. This result can be compared to the budget for rural and urban electrification (CFA2,000 million) shown in Table 1.20.