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INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT
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ECONOMIC DEVELOPMENT IN MALI
EVOLUTION, PROBLEMS AND PROSPECTS
(in five volumes)

VOLUME III
POWER AND WATER

May 20, 1970

Western Africa Department

EXCHANGE RATES

Prior to May 4, 1967

MF 246.853 = U.S. \$1.00
MF 1 = CFAF 1

May 4, 1967 to August 11, 1969

MF 493.706 = U.S. \$1.00
MF 1 = CFAF 0.50

After August 11, 1969

MF 555.419 = U.S. \$1.00
MF 1 = CFAF 0.50

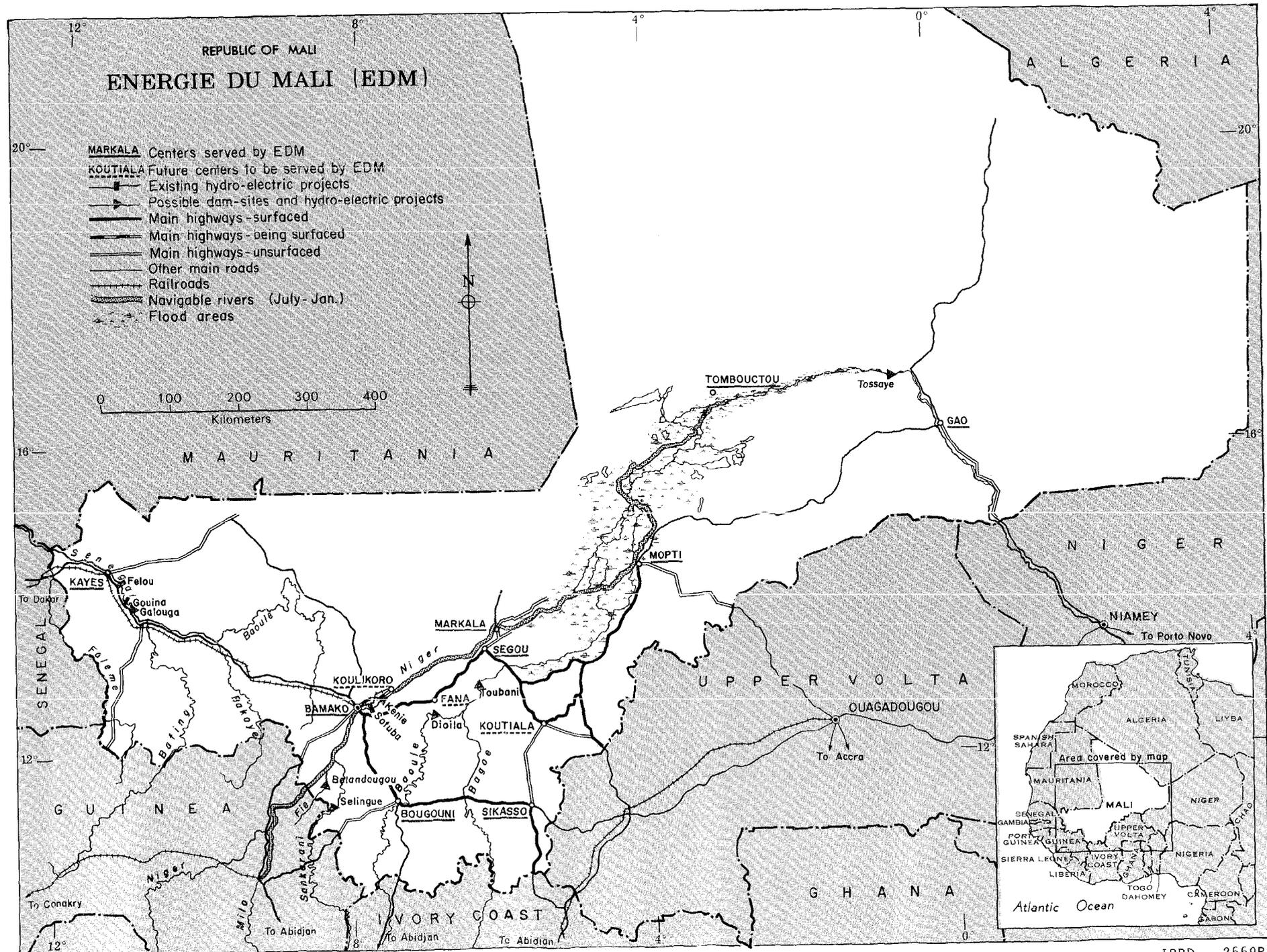
Note: Cost and investment figures given in this report in Mali francs have not been adjusted for the partial devaluation which took place on August 11, 1969. Any dollar equivalents cited are at the previous rate of exchange unless otherwise noted.

ECONOMIC DEVELOPMENT IN MALI

POWER AND WATER

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VOLUME III

ECONOMIC DEVELOPMENT IN MALI

POWER AND WATER

SUMMARY

1. Energie du Mali (EDM) established by the Government of Mali in 1961 with participation of Electricite' de France (EdF) and the Caisse Central de Coopération Economique (CCCE) is responsible for generation, transmission and distribution of power and distribution of water. Of its present share capital of MF100 million (US\$200,000), 55 percent is owned by the Government, 35 percent by CCCE and 10 percent by EdF.
2. EDM presently serves eight independent centers. Installed capacity totals 17.9 MW of which 5.9 MW are hydro (Sotuba plant of 5.4 MW serving Bamako, the capital, and Felou of 0.5 MW serving Kayes) and 12.0 MW are thermal (diesel).
3. In 1967/68 generation totalled 34.2 GWh an increase of 5 percent over the previous year. Of this, Bamako required 28.9 GWh or about 85 percent of all generation in Mali. The average annual growth rate for the period 1962-68 was about 10.3 percent, but in 1965-68 it was only 6.3 percent.
4. The Sotuba hydro plant, commissioned in 1966, was financed with loans and credits to the Government totalling MF4,310 million (US\$8.6 million). This plant is still owned by the Government.
5. EDM from the beginning was faced with financial and management difficulties aggravated by the devaluation in April 1967 of the Mali Franc from MF250 to MF500 to the US dollar.
6. Recognizing EDM's problems, the Government requested EdF to carry out a study of EDM's management, organization, accountancy procedures and system, assets valuation, tariff structure, depreciation and staffing policies, and the power market, and to make recommendations for the transfer of the Sotuba plant to EDM. Financed by the Fonds d'Aide et de Coopération (FAC), this study is expected to be completed by mid-1970.
7. EDM's financial situation is complex. Power and water operations are not separated adequately. On June 30, 1968 total fixed assets, excluding the Sotuba plant, were valued at MF3,970.5 million (US\$7.9 million) and accumulated depreciation amounted to MF1,193.4 million (US\$2.4 million). Outstanding loans on the same date totalled MF1,392.4 million (US\$2.8 million) of which MF520 million (US\$1.0 million) are short-term debts.
8. It is difficult to determine a meaningful rate of return on net fixed assets in operation. An estimate made for the fiscal year 1967/68 indicates that, excluding Sotuba, a rate of return of about 6.9 percent was earned. Following devaluation the tariffs were adjusted by a surcharge of 47 percent for power and 50 percent for water. These were, however, put into force after a delay of nine months, so that 1967/68 revenues do not fully reflect the surcharge. Estimates made for 1968/69, with revenues fully reflecting the tariff surcharge, indicate a rate of return, excluding Sotuba, of about 19 percent or including Sotuba, of about 8 percent.

9. The most important issue is arrears. Cumulative gross customer receivables by the end of 1967/68 totalled MF1,001.7 million (US\$2.0 million) and equalled about 84 percent of 1967/68 revenues from the sale of power and water. Principal debtors are the municipalities of Bamako and Kayes.

10. An expansion program for 1969-73 foresees total investments of about MF4,442 million (US\$8.9 million). Of this MF2,449 million (US\$4.9 million) is needed for water supply; MF1,749 million (US\$3.5 million) for power; and MF244 million (US\$0.5 million) for housing, etc.

11. EDM can finance 58 percent of this program from internal cash generation (MF2,567 million or US\$5.1 million). It has obtained FAC and FED financing in an amount of MF1,265 million (US\$2.6 million) and a French supplier's credit of about MF230 million (US\$0.5 million) for a new diesel unit of 4.5 MW at Bamako. Financing of secondary water distribution facilities in Bamako is still to be arranged (MF300 million or US\$0.6 million). No allowance is made in the program for additional thermal facilities that may be required in Bamako by 1973 or 1974 or the provision of water supply in certain provincial towns.

12. To meet longer-term power demand the Government wants to carry out the Selingué hydro-project on the Sankarani River. Located 140 km. south of Bamako, the Sankarani River forms the boundary between Guinea and Mali. Since Guinea territory would be flooded, implementation of the Selingué project would be subject to prior agreement with the Government of Guinea. Final decision on the project must in any event await the completion of detailed studies which, among other things, should examine the relative merits of hydro and thermal plant, including the need for additional thermal facilities before construction of Selingué may be warranted.

13. EDM's future situation will depend on the result of EdF's organization and management study, power market survey and load forecast, and the ability of EDM to implement the recommendations made.

14. The mission did not consider power projects on the Senegal River or its tributaries which have been under investigation within the framework of the Senegal River Basin Study. The ultimate justification of any such project is in any event critically dependent on the outcome of studies regarding the possibility of making effective and economic use of considerable amount of power and energy that could be generated.

POWER AND WATER

I. INTRODUCTION

1. The electrification of Mali began in 1928 with the installation of a 500-kW hydro-electric unit at Felow near Kayes. In the following years various diesel generating units were installed at Bamako, Bougouni, Gao, Kayes, Mopti and Segou.
2. Initially the Colonial Authorities were responsible for public power supply, appointing firms to manage, operate, and maintain generating and distribution facilities. Later concessions were granted, first in 1951 to the Energie Electrique d'Afrique de l'Ouest Française (AOF) and finally in 1957 to the Société Africaine d'Electricité (SAE). In January 1961, after gaining independence, the Government of Mali took over all power generating, transmission, and distribution, and water distribution facilities.
3. Together with Electricité de France (EdF), and the Caisse Centrale de Coopération Economique (CCCE), the Government then established Energie du Mali (EDM), making it responsible for power generation, transmission, and distribution, and for the distribution of water in the whole of the Republic. With an initial share capital of MF50 million (US\$200,000) EDM is owned by the Republic of Mali (55 percent), CCCE (35 percent), and EdF (10 percent).
4. The concession agreement between the Republic and EDM was signed on January 17, 1961 for a period of 30 years up to December 31, 1990. The conditions applying to the concession are dated August 6, 1962. The facilities taken over by the Republic following the nationalization of SAE were placed at EDM's disposal against a nominal payment of MF1.00 on the condition that EDM maintains the facilities and sets up a depreciation reserve for them.
5. In the fiscal year 1967/68, 33.9 GWh were produced by EDM. Of this amount 27.7 GWh were sold to 14,300 consumers, and 6.2 GWh or 18.3 percent represented transmission and distribution losses, and auxiliary uses. Maximum demand totalled 7.3 MW and the average annual load factor was about 52.5 percent. Installed capacity amounted to 17.9 MW of which 5.9 MW was hydro and 12.0 MW thermal (diesel).
6. Bamako, the capital, consumed 23.6 GWh in 1967/68 or about 85 percent of all power requirements in Mali. The number of consumers in Bamako totalled 9,400 or 66 percent of the total.
7. Energy was utilized on average for:
 - i. public lighting and administration 3 percent,
 - ii. industries and commerce 47 percent, and
 - iii. households 50 percent.

II. ENERGIE DU MALI

8. With headquarters in Bamako, EDM is governed by a Board of seven members elected for three-year terms. The seven members elect one member to act as president and one or two to act as vice-presidents. The Board may entrust the management of EDM to a firm or appoint a Managing Director responsible for day-to-day operations. The latter alternative was adopted. The Board appoints or dismisses all employees and fixes their salaries.

9. In accordance with Mali law, EDM is subject to State control by (a) a State Comptroller appointed by the Council of Ministers who is attached to the office of the President of the Republic, and (b) two or more auditors appointed by the shareholders for three-year terms, one of whom must be the auditor of the Republic. The Managing Director and the auditors may not be members of Parliament or Government Ministers.

10. A shareholders' meeting is convened by the Board at least once per year within six months of the close of the fiscal year (July 1-June 30) to approve the balance sheet and income statement; to determine the level of share capital; to fix the dividend rate; and to elect Board members and auditors.

11. EDM's statutes define net income as gross revenue less operating expenses, general charges, interest, debt amortization, depreciation and reserves deemed necessary by the Board. After deduction from net income of any losses incurred in previous years any remaining profit is allocated to:

- i) a reserve fund, to which 5 percent of net income is assigned until the fund reaches 10 percent of the share capital;
- ii) a dividend of 5 percent on the share capital; and
- iii) a social fund, in an amount determined by the shareholders.

Any surplus remaining is used either to create extraordinary reserves, to provide for a pension fund, or to amortize share capital.

12. Since establishment, EDM has been faced with a number of difficulties -- economic, financial and technical. Even before devaluation EDM was unable to assure proper maintenance. This situation was aggravated by the devaluation of the Mali Franc in April 1967 from MF250 = US\$1 to MF500 = US\$1 and the delay in adjusting tariffs. As a consequence, it was difficult for EDM to prepare financial forecasts and long-term expansion programs. The major technical and financial problems, however, were solved in that the Fonds d'Aide et de Coopération (FAC), CCCE and suppliers provided loans and credits to the Government in 1964 to construct the Sotuba hydroelectric plant near Bamako and to modernize the Bamako power distribution system. However, Sotuba, although operated and maintained by EDM, is still owned by the Government since the legal and financial problems involved in the transfer of this plant to EDM have not yet been solved. Since devaluation the Fonds Européen de Développement (FED) has assured financing of a small water supply project for Tombouctou and has been actively considering a water supply project for Bamako.

13. The Government, recognizing EDM's difficulties, obtained a loan from FAC of MF29 million (US\$58,000) for a study to review EDM's management and organization. This study is being carried out by the Inspection Générale pour la Coopération hors Métropole (IGECO), an EdF subsidiary, and is scheduled for completion by mid-1970.

14. This study will cover the following aspects:

- i) Organization and management including personnel, salaries, promotions, insurance, and social benefit policies;
- ii) accountancy, including procedure and systems review, capability of existing staff, state of existing accounts, meter reading, billing and collection procedures, procedures for dealing with arrears, stores management, and asset valuation;
- iii) legal aspects of the existing concession agreement;
- iv) financial implications of a Sotuba transfer;
- v) power market survey and forecast of demand up to 1980;
- vi) investment program and financing plan; and
- vii) tariff review.

15. This study is essential for EDM's future. If Bank/IDA financing is envisaged, the IGECO/EdF report should be reviewed by the Bank/IDA and assurances should be obtained that recommendations leading to efficient and economical operations will be implemented without delay.

16. EDM is faced with a lack of qualified staff especially in the middle echelon positions. There is practically no qualified staff to serve between the engineers and the workmen most of whom are illiterate. EDM's Board recognized the problem early and with the assistance of EdF/IGECO established a training center. The specific task of this center is to train foremen, electricians and mechanics in a program covering eighteen-month periods. First started in early 1966, two programs have been carried out, the first of which was for electricians and the second for mechanics. An additional program is planned for workmen whose professional capability cannot be fully utilized, because of their lack of knowledge of the French language. This program would cover linesmen, maintenance personnel, and diesel mechanics.

17. EDM presently has a staff of about 600 for its power and water services. The EdF study will review actual needs and make recommendations on the staff requirements necessary for efficient operation.

22. Consumption for public lighting after a substantial increase in 1961 and 1962 has remained virtually stationary in the last years. Industrial and commercial use increased in 1965 and 1966 when a number of small enterprises such as cigarette, match and shoe factories in Bamako, refrigerated slaughterhouses in Bamako and in Gao, and cotton ginning factories in Segou and Sikasso came into service and were supplied with power.

23. Generation in GWh at the eight centers presently served by EDM is given below:

| | <u>1965</u> | | <u>1966</u> | | <u>1967</u> | | <u>1968</u> | | Average Annual Growth Rate 1965/68 in % |
|---------------|-------------|-------------------|-------------|-------------------|-------------|-------------------|-------------|-------------------|---|
| | <u>GWh</u> | <u>% of Total</u> | |
| Bamako | 23.8 | 85.0 | 26.8 | 84.8 | 28.5 | 85.9 | 28.3 | 84.2 | 6.0 |
| Kayes | 0.9 | 3.2 | 1.1 | 3.4 | 1.1 | 3.3 | 1.2 | 3.6 | 10.1 |
| Mopti | 0.5 | 1.8 | 0.6 | 1.9 | 0.6 | 1.8 | 0.7 | 2.1 | 11.9 |
| Gao | 0.6 | 2.1 | 0.6 | 1.9 | 0.7 | 2.1 | 0.7 | 2.1 | 5.4 |
| Sikasso | 0.4 | 1.4 | 0.5 | 1.7 | 0.4 | 1.2 | 0.5 | 1.5 | 7.7 |
| Bougouni | 0.1 | 0.4 | 0.1 | 0.3 | 0.1 | 0.3 | 0.1 | 0.3 | - |
| Markala-Segou | 1.6 | 5.7 | 1.8 | 5.7 | 1.6 | 4.8 | 1.9 | 5.6 | 6.0 |
| Tombouctou | 0.1 | 0.4 | 0.1 | 0.3 | 0.2 | 0.6 | 0.2 | 0.6 | 26.0 |
| TOTAL | <u>28.0</u> | <u>100.0</u> | <u>31.6</u> | <u>100.0</u> | <u>33.2</u> | <u>100.0</u> | <u>33.6</u> | <u>100.0</u> | <u>6.3</u> |

24. The growth rate of 6.3 percent over the past three years is low for a developing country. This reflects partly the stagnation of the economy and partly EDM's inability for financial reasons to connect new areas, especially in Bamako, that have as yet no power. A few industrial plants have also installed their own generating equipment.

B. Future

25. A forecast of future power requirements has not been made by EDM. A power market survey is, however, included in the IGECO/EdF study and a forecast of future needs up to 1980 will be made. The following breakdown attempts to forecast future demand assuming an average annual growth rate of about 6 percent experienced over the past years in existing supply areas, and in addition:

- i) electrification of new quarters in Bamako and centers such as Fana, Koutiala and Koulikoro; and
- ii) new industrial loads.

| | <u>1968</u> | <u>1969</u> | <u>1970</u> | <u>1971</u> | <u>1972</u> | <u>1973</u> | <u>1974</u> | <u>1975</u> |
|---------------------------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| Generation in GWh | 33.6 | 35.6 | 44.3 | 47.5 | 51.3 | 55.0 | 58.0 | 60.9 |
| Losses in GWh | 5.1 | 5.3 | 6.6 | 7.1 | 7.7 | 8.2 | 8.7 | 9.1 |
| Sales in GWh | 28.5 | 30.3 | 37.7 | 40.4 | 43.6 | 46.8 | 49.3 | 51.8 |
| Growth of sales in percent | 3.0 | 6.0 | 24.5 | 7.2 | 8.0 | 7.5 | 5.5 | 5.0 |
| Losses as percent of generation | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| Maximum demand in MW | 7.3 | 7.6 | 9.7 | 10.5 | 11.3 | 12.1 | 12.7 | 13.3 |
| Average annual load factor in percent | 52.5 | 52.5 | 52.0 | 52.0 | 51.5 | 52.0 | 52.0 | 52.5 |

Over the period 1968-1975 the above forecast of sales corresponds to an average annual growth rate of about 8 percent.

IV. PRESENT GENERATING AND DISTRIBUTION FACILITIES

A. Generation

26. In 1961 when EDM was formed, six centers, Bamako, Bougouni, Gao, Kayes, Mopti and Segou were served with power. With the exception of the small 500-kW hydro unit at Felou near Kayes, all generation was thermal (diesel). Installed capacity in 1961 totalled 8.0 MW.

27. In February 1964, Sikasso was electrified and three units totalling 250-kVA were installed. In October 1964, the Gao generating station was strengthened by the installation of a 310-kVA unit. In December 1964, the diesel generating station at Markala operated by the Office du Niger, was taken over by EDM and integrated with Segou. At Markala, three units totalling 1,675 kVA are installed and the power generated is utilized by the Office du Niger, the irrigation authority at Markala, and the balance transmitted to Segou, a distance of 40 km, for general distribution. In September 1965, Tombouctou was electrified and three units totalling 250 kVA were installed. At the end of 1965, the Bamako diesel plant was strengthened by the addition of a 4,000-kVA unit and a 1,000-kVA unit was retired.

28. In 1964 construction started on the Sotuba hydroelectric plant, 8 km downstream of Bamako on the Niger River. Feasibility studies and design were carried out by EdF/IGECO, and the Service de l'Hydraulique du Mali (Ministry of Public Works, Communications and Energy), assisted by IGECO, supervised construction. Equipped with two Kaplan units operating under a gross head of 3.5-7.4 m and a flow per unit of 60.0 m³/sec, installed capacity totals 5.4 MW. An average of 35 GWh can be produced annually. The first unit came into service in April 1966 and the second in June 1966. This plant serves the Bamako power market. The low head during the high-flow period (August, September and October) and the low flow (March, April, May) -- minimum flow about 30 m³/sec -- greatly influence the utilization of this plant. No upstream storage is available.

29. Present generating capacity installed and operated by EDM is given below:

| | <u>Thermal</u> | <u>Hydro</u> | <u>Total</u> |
|---------------|----------------|--------------|---------------|
| | <u>kw</u> | <u>kw</u> | <u>kw</u> |
| 1. Bamako | (5) 8,800 | (2) 5,440 | 14,240 |
| 2. Bougouni | (2) 96 | - | 96 |
| 3. Gao | (4) 480 | - | 480 |
| 4. Kayes | (2) 560 | (1) 500 | 1,060 |
| 5. Mopti | (3) 296 | - | 296 |
| 6. Markala | (3) 1,240 | - | 1,240 |
| 7. Sikasso | (4) 328 | - | 328 |
| 8. Tombouctou | (3) 200 | - | 200 |
| TOTAL | <u>12,000</u> | <u>5,940</u> | <u>17,940</u> |

Numbers in () denote number of units installed.

B. Transmission

30. With the exception of Segou, each center is served by its own generating plant. Transmission lines are limited to:

- i. Markala - Segou 15 kV, 44 km;
- ii. Felou - Kayes 30 kV, 13 km; and
- iii. Sotuba - Bamako 30 kV, 11.9 km of which 4.2 km by cable.

C. Distribution

31. At the end of 1963, 5.5-kV medium voltage distribution totalled 85 km and by the end of 1966, 100 km. The electrification of Sikasso and Tombouctou required 2.2 km and 5.2 km of medium voltage, and 18.5 km and 11.0 km of low voltage distribution respectively. Medium voltage/low voltage transformer stations totalled 141. Three types are used, namely: i) standardized concrete structures with three feeder cells and two transformers up to 250 kVA; ii) prefabricated steel-sheet encased stations for one transformer of 100 kVA or 250 kVA capacity; and iii) pole-mounted transformers up to 40 kVA. In 1967 the Bamako 5.5-kV system was changed to 15 kV.

V. FUTURE DEVELOPMENTS

32. To meet future increased demand EDM, its predecessors and the Government have to date investigated various hydroelectric projects. These are described in the following paragraphs:

A. Kenie Rapids

33. Situated 35 km downstream of Bamako on the Niger River, two low head alternative developments are possible.

| <u>Petit Kenie</u> | <u>2 Units</u> | <u>4 Units</u> | <u>8 Units</u> |
|---|----------------|----------------|----------------|
| Installed capacity in kW | 5,000 | 10,000 | 20,000 |
| Utilized flow m ³ /sec | 120 | 240 | 480 |
| Firm capacity in kW with no upstream storage | | | |
| i) High flow period | 2,200 | 4,400 | 8,800 |
| ii) Low flow period | 2,600 | 2,600 | 2,600 |
| Firm capacity in kW with upstream storage and 200 m ³ /sec minimum low flow regularization | | | |
| i) High flow period | 2,200 | 4,400 | 8,800 |
| ii) Low flow period | 4,250 | 8,500 | 14,000 |
| Average annual energy production in GWh without upstream storage | 30.0 | 55.0 | 100.0 |

Estimated costs (1957) without upstream storage

| | | | |
|-------------------------------------|-------|-------|-------|
| i) in millions of MF | 2,800 | 3,500 | 5,200 |
| ii) in millions of US\$ <u>1/</u> | 5.6 | 7.0 | 10.4 |
| iii) in US\$/kW installed <u>1/</u> | 1,120 | 700 | 520 |

Grand Kenié

Downstream of Petit Kenié, this alternative would require a dam, providing head only, across the Niger near the village of Manambougou.

| Average annual energy production in Gwh | Installed Capacity in kW | | |
|---|--------------------------|---------------|----------------|
| | <u>25,000</u> | <u>50,000</u> | <u>120,000</u> |
| i) without regularization | 33.0 | - 2/ | - 2/ |
| ii) with regularization, minimum 200 m ³ /sec during low flow period | 190.0 | 340.0 | 600.0 |
| Firm capacity in kW | | | |
| i) without regularization | 3,800 | - 2/ | - 2/ |
| ii) with regularization, minimum 200 m ³ /sec during low flow period | 21,000 | 21,000 | 21,000 |
| Cost estimate (1957) without regularization. | | | |
| i) Civil works - dam | | | |
| - in millions of MF | 7,400 | 7,400 | 7,400 |
| - in millions of US\$ <u>1/</u> | 14.8 | 14.8 | 14.8 |
| ii) Power plant | | | |
| - in millions of MF | 2,650 | 5,300 | 12,700 |
| - in millions of US\$ <u>1/</u> | 5.3 | 10.6 | 25.4 |
| iii) Total | | | |
| - in millions of MF | 10,050 | 12,700 | 20,100 |
| - in millions of US\$ <u>1/</u> | 20.1 | 25.4 | 40.2 |
| - in US\$/kW installed <u>1/</u> | 804 | 508 | 335 |

B. Sotuba

34. This plant, taken into operation in 1966 with two units totalling 5.4 MW, presently supplies Bamako with a maximum of 4,850 kW of which 2,600 kW are firm. Output is however limited by flow and head conditions. With

1/ At 1968 exchange rate.

2/ Without upstream regularization installation of more than 25 MW not justified.

a river flow of 7,900 m³/sec (1 in 10 flood) output is 2,600 kW and with 21.0 m³/sec (1 in 10 low flow), 1,000 kW. Utilizing the storage provided by the headrace channel, 2,600 kW can be provided for peaking purposes during the low-flow period.

35. Sotuba can be extended by two further identical units. The headrace channel is already designed for four unit operation. However, the diversion weir across the Niger would have to be raised 1 m. With four units installed, 9,700 kW would become available to Bamako and firm power would increase to 5,200 kW during the high flow period and to 1,100 kW during the low flow period due to increased head. For peaking purposes 3,800 kW could be provided. Average annual energy production with four units in service would increase from 35 GWh to 62 GWh without any upstream storage and river flow regularization. No cost estimate for the power plant extension has yet been prepared.

C. Selingué

36. The only possibility within Mali to regulate the Niger River during low flow periods exists at Selingué on the Sankarani River, a tributary of the Niger, about 140 km south of Bamako. The Sankarani near Selingué forms the border between Mali and Guinea. The Sankarani flow at Selingué on average corresponds to about 25 percent of the Niger flow at Koulikoro, east of Bamako. A 20 m high dam with a crest at about 348.5 m would provide a gross storage of 1,570 million m³ and a useful storage of 1,410 million m³. The full supply level providing this storage would be at 347 m. This storage would guarantee a minimum flow of the Niger at Koulikoro of about 120 m³/sec compared to about 30 m³/sec on average at present. Such a regularization would benefit the existing Sotuba hydro plant and any other hydro plants downstream of Sotuba and upstream of the Office du Niger irrigation diversion weir at Markala.

37. A power plant equipped with four units, each utilizing a flow of 50 m³/sec, would have an installed capacity of 20 MW. In an average year 100 GWh could be generated and 19 MW would become available to Bamako with 8.5 MW being firm.

Selingué with Sotuba would provide a capacity of:

Sotuba 2 Units

| | <u>Capacity in kW</u> | | |
|----------------|-----------------------|-------------------------|------------------------|
| | <u>Maximum</u> | <u>High Flow Period</u> | <u>Low Flow Period</u> |
| Sotuba 2 units | 4,850 | 2,600 | 4,850 |
| Selingué | <u>19,000</u> | <u>12,000</u> | <u>8,500</u> |
| Total | <u>23,850</u> | <u>14,600</u> | <u>13,350</u> |

Sotuba 4 Units

| | <u>Capacity in kW</u> | | |
|----------------|-----------------------|-------------------------|------------------------|
| | <u>Maximum</u> | <u>High Flow Period</u> | <u>Low Flow Period</u> |
| Sotuba 4 units | 9,700 | 5,200 | 6,000 |
| Selingué | <u>19,000</u> | <u>12,000</u> | <u>8,500</u> |
| Total | <u>28,700</u> | <u>17,200</u> | <u>14,500</u> |

Bamako is presently served by Sotuba and the existing thermal (diesel) plant as follows:

| | <u>Capacity in kW</u> | |
|----------------|-----------------------|-----------------|
| | <u>Maximum</u> | <u>Firm</u> |
| Thermal plant | 8,800 | 6,800 <u>1/</u> |
| Sotuba 2 units | <u>4,850</u> | <u>2,600</u> |
| Total | <u>13,650</u> | <u>9,400</u> |

38. Total capacity available to Bamako with Sotuba, Selingué and the thermal plant would therefore total:

| | <u>Capacity in kW</u> | | |
|-------------------------|-----------------------|-------------------------|------------------------|
| | <u>Maximum</u> | <u>High Flow Period</u> | <u>Low Flow Period</u> |
| Thermal plant <u>2/</u> | 11,700 | 11,700 | 11,700 |
| Sotuba 4 units | 9,700 | 5,200 | 6,000 |
| Selingué | <u>19,000</u> | <u>12,000</u> | <u>8,500</u> |
| Total | <u>40,400</u> | <u>28,900</u> | <u>26,200</u> |

39. Allowing for spare capacity equal to the largest unit in the system, 21.2 MW would be available. If an average annual growth rate in Bamako of about 10 percent is assumed the above three plants would meet demand until about 1981.

40. Before any decision is made in respect to the Selingué reservoir project, the Sotuba extension, the Selingué power plant, or the Kenié project, more detailed investigations are essential. These investigations should cover:

- i) a power market survey. This has already been entrusted to EdF/IGECO as part of their management and organization review;

1/ During high flow period one 2,000-kW diesel unit placed on standby

2/ Two 800-kW diesel units retired and one 4,500-kW unit added to meet interim demand.

- ii) up-dating of the available Selingué study and cost estimate with supplementary field work. The Direction de l'Hydraulique of Ministry of Public Works, Communications and Energy (MPWCE) through the Government of Mali has requested UNDP assistance for this work. Expected to be completed by late 1971, MPWCE foresees that Selingué construction could begin in 1972/73 and that the dam could be in service by 1975/76. A power plant would not necessarily be included in this phase since transmission lines over 140 km in length would be needed and it might be more economical to extend first the Sotuba plant to be followed by the Selingué plant; and
- iii) a study to determine the optimum use of the Selingué reservoir so that power, irrigation and navigation benefits are maximized, since power generation at Selingué and any downstream plants will be affected by the needs of irrigation and navigation.

These investigations should provide the basis for a comparison of the costs and benefits of alternative solutions which would include (1) construction of Selingué, with installment of power plant at both Selingué and Sotuba; (2) the Kenié hydro-electric project described in paragraph 33; (3) construction of Selingué without immediate installation of generating facilities there, but with installation of additional plant at Sotuba to provide 2.6 MW more firm power and a thermal plant providing 9.4 MW, and (4) additional thermal plant constructed in stages up to 1.2 MW. The capital cost of these alternatives varies widely; solution (4), for example, would involve an investment of only \$3 million, whereas any solution entailing the construction of Selingué would cost over \$20 million. The saving in investment cost in the case of the thermal alternative would, of course, have to be offset by the recurring cost of fuel. A UNDP-financed study of the Selingué project is to get under way in October 1970 and is expected to take two and a half years. It is important that its scope be broadened to include the economic as well as the engineering aspects of the project. Even if the project is eventually carried out, the growth of power demand in the Bamako area will require the installation of additional thermal facilities - a thermal plant of 4,500 KW by the end of 1971 and another of about the same capacity a few years later.

41. The Sankarani and the Niger River are international inland waterways and the Selingué Reservoir would flood 2,150 ha of Guinea territory of which 210 ha is cultivated. Early negotiations and an agreement between Guinea and Mali are therefore essential. Any increased use of the Niger flow for irrigation purposes could affect both Niger and Nigeria (Kainji). The possible consequences would have to be determined and existing international agreements may require modification and clarification. If flooding of Guinea territory were to be avoided the full supply level would have to be reduced by 6 m to 341 m, reducing gross storage to 298 million m³. This would provide virtually no regulation and would greatly affect the economic justification of the project.

42. Mali should negotiate an appropriate agreement with Guinea with respect to the Selingué project. These negotiations should also seek to establish a joint advance flood warning system.

D. Balandougou

43. This project on the Fie River, a right bank tributary of the Niger, joining the Niger about 30 km upstream of the Niger-Sankarani junction, is about 120 km from Bamako. A 26 m high dam would provide a storage of about 1,200 million m³. With a catchment area of about 4,500 km², average run-off is about 1,750 million m³. A power plant at the foot of the dam would have an installed capacity of 10 MW and 40 Gwh could be produced annually. The storage would extend about 40 km into Guinea. No cost estimate is available.

E. Dioila Project

44. Located on the Baoule River, a tributary of the Bani, the project is about 16 km upstream of Dioila and about 100 km to the south of Bamako. A 24-m dam would provide a useful storage of about 1,200 million m³. A power plant at the foot of the dam would have an installed capacity of 24 MW and could produce 120 GWh annually. No cost estimate is available.

F. Markala

45. The head created by the Office du Niger's diversion weir could be utilized by the installation of two 500-kW bulb-turbine generator sets. Each unit would utilize 12.5 m³/sec. Available output however is limited since irrigation has priority and would be zero during the low flow period. During the high flow period in September and October output would also be zero because of loss of head.

G. Tossaye Rapids

46. Twenty-five km upstream of Bourem on the Niger, a 16-m dam could create a storage of about 800 million m³ of which 560 million m³ would be useful. A power plant at the foot of the dam with an installed capacity of 15 MW would utilize a flow of 300 m³/sec and could produce annually 90 GWh. No cost estimate is available.

H. Toubani

47. Located 2 km below the village of Toubani on the Bani river and 80 km downstream of Dioila, this project would benefit from the regularization provided by the Dioila project. With an installed capacity of 7.5 MW, 34 GWh could be produced annually. No cost estimate is available.

I. Sénégal River Basin

48. A substantial hydro potential exists in the Senegal basin and this is presently being investigated in great detail. The four countries, Mali, Guinea, Sénégal and Mauritania formed the Organisation des Etats Riverains du Fleuve Sénégal (OERS) to promote the development of the basin. Studies still underway are being financed to a large part by the United Nations Development Program (UNDP). A preliminary report was available in December 1968.

49. This report proposed a dam at Galouga near Gouina in Mali to regularize the Sénégal flow thus improving the navigability of the Sénégal between St. Louis on the coast and Kayes in Mali. In addition, substantial power and energy could be produced and could result in the setting up of power intensive industries, such as a steel mill, if the mineral deposits

of the area can be economically exploited. Regularization of the Senegal would also permit the irrigation of areas in Senegal and Mauritania. One or two smaller dams upstream of Gouina would allow the area of Maqui to be irrigated for the production of cotton and sugar. Hydro-agricultural studies are still in progress. The ultimate justification of any power project on the Senegal River is critically dependent on the outcome of studies regarding the possibility of making effective and economic use of the considerable amount of power and energy that could be generated.

VI. INVESTMENT PROGRAM

50. Up to 1968 EDM was not in a position to prepare any long-term investment programs due to economic, financial and technical difficulties and lack of qualified staff. EDM's financial position was aggravated by the April 1967 devaluation and the delay in adjusting tariffs to meet the new situation. In January 1969, however, a provisional investment program covering the period 1969-1973 was prepared. This program is not complete since a number of projects included have not been studied in detail and no costs have been determined. Also, no provisions have been made for major projects which would start in 1973.

51. This program, covering projects in Bamako, Segou-Markala, Mopti, Gao, Tombouctou, Sikasso, Kayes and Bougouni in addition to the electrification of new centers - Fana, Koutiala and Koulikoro - would require investments totalling MF4,442 million (US\$8.9 million) as indicated below:

| | <u>In millions of Mali Francs</u> | | | | |
|-------------|-----------------------------------|---------------------|---------------------|----------------|----------------|
| | <u>Generation</u> | <u>Distribution</u> | <u>Water Supply</u> | <u>Housing</u> | <u>Total</u> |
| 1969 | 216.0 | 394.0 | 441.0 | 24.0 | 1,075.0 |
| 1970 & 1971 | 399.0 | 347.0 | 1,005.0 | 220.0 | 1,971.0 |
| 1972 & 1973 | <u>90.0</u> | <u>303.0</u> | <u>1,003.0</u> | - | <u>1,396.0</u> |
| Total | <u>705.0</u> | <u>1,044.0</u> | <u>2,449.0</u> | <u>244.0</u> | <u>4,442.0</u> |

| | <u>In thousands of US dollars</u> | | | | |
|-------------|-----------------------------------|---------------------|---------------------|----------------|----------------|
| | <u>Generation</u> | <u>Distribution</u> | <u>Water Supply</u> | <u>Housing</u> | <u>Total</u> |
| 1969 | 432.0 | 788.0 | 882.0 | 48.0 | 2,150.0 |
| 1970 & 1971 | 798.0 | 694.0 | 2,010.0 | 440.0 | 3,942.0 |
| 1972 & 1973 | <u>180.0</u> | <u>606.0</u> | <u>2,006.0</u> | - | <u>2,792.0</u> |
| Total | <u>1,410.0</u> | <u>2,088.0</u> | <u>4,898.0</u> | <u>488.0</u> | <u>8,884.0</u> |

52. The most urgent and high priority items in the program are the water supply projects, especially for Bamako. This project studied in 1962, was scheduled for construction in 1963-64. Financing in the form of a medium-term suppliers' credit was available but the Compagnie Française d' Assurance et de Crédit à l'Exportation (COFACE) was not in a position to guarantee the credit. Since then the water situation has become more critical from year to year.

53. In 1966 FED (Fonds Européen de Développement) financed a study and priorities were established. In the second half of 1969 FED agreed to provide MF1,170 million (US\$2.4 million) to finance the expansion of the pumping and treatment plant from 750 m³/h to 1,330 m³/h; the construction of three underground reservoirs totalling 7,850 m³ and a 300 m³ water tower; two intermediate pumping stations; main feeders; 50 fountains; and 25 fire hydrants. Secondary distribution facilities estimated to cost MF523 million (US\$1.05 million) still remain to be financed.

54. FAC has granted EDM a loan of MF95 million (US\$190,000) to finance a 575 kVA diesel generating unit at Segou-Markala (MF50 million) and to assist in financing part of the costs of the Fana electrification (MF45 million). In addition FAC has granted a loan of MF29 million to the Government for the review by EdF/IGECO of EDM's management and organization. This amount is not included in EDM's investment program. From the original loan by CCCE to the Government for the Sotuba hydro plant an undisbursed amount of MF200-300 million remains. This amount could be placed at EDM's disposal to finance items not included in the investment program.

55. Out of investments totalling MF4,442 million (US\$8.9 million) financing in an amount of MF1,265 million (US\$2.6 million) had been arranged by mid-1969, leaving a total of MF3,177 million (US\$6.4 million) to be financed by EDM or other sources.

56. To supplement the external financing already obtained and its own internal cash generation estimated at MF2,567 million, the EDM has been seeking to borrow some additional funds. It has obtained a supplier's credit, guaranteed by the French export credit insurance company COFACE, to purchase the additional thermal plant required for installation in Bamako by 1971. The ADB has been approached for a loan of MF300 million (US\$0.6 million) for the Bamako water distribution project. However, the Government considers ADB's terms unfavorable and is now seeking IDA financing of this project as well as of certain other water supply projects outside Bamako.

57. Excluding the undisbursed portion of Sotuba loans made to the Government, EDM's 1969-73 financing plan can be summarized as follows:

| | <u>In millions of MF</u> | <u>% of Total</u> | <u>In millions of US\$</u> |
|---|------------------------------|-----------------------|--------------------------------|
| <u>Total Investment Requirements</u> | 4,442.0 | 100 | 8.9 |
| <u>Sources</u> | | | |
| FED and FAC financing | 1,265.0 | 28 | 2.6 |
| Other external financing (partly to be obtained) | 610.0 | 14 | 1.2 |
| Internal cash generation 1969-73 | | | |
| Estimated (net) | 3,040.0 | | |
| Increase in working capital | 473.0 | | |
| Internal cash generation applied to construction | <u>2,567.0</u> | <u>58</u> | <u>5.1</u> |
| Total Sources | <u>4,442.0</u> | <u>100</u> | <u>8.9</u> |

58. Construction of the FED water supply project is scheduled to start in early 1970, with tenders being issued in the fall of 1969, and should be completed in March/April 1972. The water distribution project could start in early 1971 with tenders issued in the summer of 1970. The most important and urgent distribution elements could therefore be ready for service at the same time as the FED project.

VII. FINANCIAL SITUATION

59. EDM's financial position based on available information can be summarized as follows.

A. Balance Sheets

| June 30 | (MF millions) | | | | |
|-----------------------------|----------------|----------------|----------------|----------------|----------------|
| <u>Assets</u> | <u>1964</u> | <u>1965</u> | <u>1966</u> | <u>1967</u> | <u>1968</u> |
| Fixed assets | 1,775.5 | 1,843.5 | 2,338.0 | 3,885.5 | 3,970.5 |
| Accumulated depreciation | <u>446.2</u> | <u>584.6</u> | <u>708.2</u> | <u>863.5</u> | <u>1,193.4</u> |
| Net fixed assets | 1,309.3 | 1,258.9 | 1,629.8 | 3,022.0 | 2,777.1 |
| Work in progress | <u>107.7</u> | <u>272.9</u> | <u>52.0</u> | <u>42.1</u> | <u>35.3</u> |
| Total | <u>1,417.0</u> | <u>1,531.8</u> | <u>1,681.8</u> | <u>3,064.1</u> | <u>2,812.4</u> |

| <u>Balance Sheets(continued)</u> | <u>1964</u> | <u>1965</u> | <u>1966</u> | <u>1967</u> | <u>1968</u> |
|----------------------------------|----------------|----------------|----------------|----------------|----------------|
| <u>Current Assets</u> | | | | | |
| Customer receivables (net) | 567.3 | 654.9 | 741.5 | 761.7 | 979.7 |
| Others | <u>332.1</u> | <u>349.0</u> | <u>345.5</u> | <u>930.4</u> | <u>861.5</u> |
| Total | <u>899.4</u> | <u>1,003.9</u> | <u>1,087.0</u> | <u>1,692.1</u> | <u>1,861.2</u> |
| <u>TOTAL ASSETS</u> | <u>2,316.4</u> | <u>2,535.7</u> | <u>2,768.8</u> | <u>4,756.2</u> | <u>4,673.6</u> |
| <u>Liabilities</u> | | | | | |
| <u>Equity</u> | | | | | |
| Share capital | 50.0 | 50.0 | 50.0 | 50.0 | 100.0 |
| Reserves | 122.8 | 165.3 | 235.9 | 1,117.0 | 1,048.1 |
| Subventions | 104.2 | 124.2 | 127.7 | 131.3 | 140.9 |
| Government equity | <u>1,171.2</u> | <u>1,171.2</u> | <u>1,171.2</u> | <u>1,952.6</u> | <u>1,952.6</u> |
| Total | <u>1,448.2</u> | <u>1,510.7</u> | <u>1,584.8</u> | <u>3,250.9</u> | <u>3,241.6</u> |
| <u>Long-term debt</u> | <u>403.4</u> | <u>479.2</u> | <u>487.6</u> | <u>809.7</u> | <u>871.7</u> |
| <u>Medium-term debt</u> | <u>62.4</u> | <u>41.6</u> | <u>176.8</u> | <u>40.0</u> | <u>40.0</u> |
| <u>Current Liabilities</u> | | | | | |
| Short term debt | 248.6 | 308.0 | 366.6 | 444.9 | 382.3 |
| Payables | 71.3 | 70.1 | 150.1 | 204.0 | 138.0 |
| Bank | <u>82.5</u> | <u>126.1</u> | <u>2.9</u> | <u>6.7</u> | <u>-</u> |
| Total current liabilities | <u>402.4</u> | <u>504.2</u> | <u>519.4</u> | <u>655.6</u> | <u>520.3</u> |
| <u>TOTAL LIABILITIES</u> | <u>2,316.4</u> | <u>2,535.7</u> | <u>2,768.6</u> | <u>4,756.2</u> | <u>4,673.6</u> |

B. Income Statements

| | <u>In millions of Mali Francs</u> | | | | |
|---------------------------|-----------------------------------|--------------|--------------|----------------|----------------|
| | <u>1964</u> | <u>1965</u> | <u>1966</u> | <u>1967</u> | <u>1968</u> |
| | 2nd 6 months only | | | | |
| <u>Operating Revenues</u> | | | | | |
| Sales of energy | 315.3 | 604.3 | 736.9 | 796.5 | 1,001.4 |
| Sales of water | 63.5 | 125.6 | 147.5 | 157.4 | 195.0 |
| Rents | 23.1 | 51.1 | 61.5 | 58.4 | 89.3 |
| Other | <u>0.7</u> | <u>1.8</u> | <u>1.7</u> | <u>1.5</u> | <u>1.9</u> |
| | <u>402.6</u> | <u>782.8</u> | <u>947.6</u> | <u>1,013.8</u> | <u>1,287.6</u> |

Income Statement (continued)

| | <u>1964</u> | <u>1965</u> | <u>1966</u> | <u>1967</u> | <u>1968</u> |
|-------------------------------|--------------|---------------|--------------|--------------|----------------|
| <u>Operating Expenses</u> | | | | | |
| Salaries | 128.6 | 281.8 | 291.1 | 326.5 | 297.7 |
| Fuel and energy | 196.5 | 359.2 | 330.7 | 278.2 | 363.3 |
| Transport | 5.7 | 14.4 | 15.3 | 17.0 | 29.3 |
| General charges | 12.9 | 18.5 | 21.8 | 23.1 | 38.1 |
| Duties | 17.5 | 30.1 | 26.8 | 34.0 | 75.6 |
| Less: Salaries capitalized | (44.1) | (56.8) | (44.7) | (21.4) | (34.7) |
| Depreciation | <u>61.4</u> | <u>118.4</u> | <u>123.6</u> | <u>155.3</u> | <u>329.9</u> |
| Total | <u>378.5</u> | <u>765.6</u> | <u>764.6</u> | <u>812.7</u> | <u>1,099.2</u> |
| <u>Operating Income</u> | <u>24.1</u> | <u>17.2</u> | <u>183.0</u> | <u>201.1</u> | <u>188.4</u> |
| Interest | 8.8 | 21.1 | 21.1 | 30.3 | 101.9 |
| Income Tax | 19.9 | 52.0 | 63.1 | 44.5 | - |
| <u>Net Income (Loss)</u> | <u>(4.6)</u> | <u>(55.9)</u> | <u>98.8</u> | <u>126.3</u> | <u>86.5</u> |

Rate of return on net
fixed assets in operation
(Sotuba hydro plant not
included) in percent

| | | | | | |
|--|-----|-----|------|------|-----|
| | 3.7 | 1.4 | 11.2 | 13.1 | 6.9 |
|--|-----|-----|------|------|-----|

60. EDM finances development and expansion projects with

- i. internal cash generation;
- ii. loans;
- iii. customer contributions; and
- iv. subventions.

By June 30, 1968 assets financed by customers totalled MF1,022.2 million of which MF670.2 million are recorded in the assets and depreciated. The balance of MF352.0 million appears on EDM's balance sheet as a pro memoria amount. Subventions received up to the same date totalled MF156.8 million.

61. Not included as an EDM asset is the Sotuba hydroelectric plant, owned by the Government of Mali. This plant built at a cost of about MF4,310 million (US\$8.6 million) with loans and credits made to the Government, is operated and maintained by EDM who services no debts, and up to date has set aside no reserves for depreciation. The EdF study on EDM's management and organization will recommend conditions under which this plant could be transferred to EDM. If the Sotuba assets were included in the determination of the rate of return at undepreciated value, EDM would have earned a return of only about 2.7 percent in 1968.

62. 1967/68 income, however, does not reflect the effect of the tariff increase following devaluation, since this increase was applied about nine months after the April 1967 devaluation. As a consequence the rate of return is small. It is expected that this will improve for the fiscal year

1968/69. With estimated operating revenues of about MF1,818 million and operating expenses at about MF1,275 million, operating income is estimated at about MF543 million. Net fixed assets in service are estimated at about MF2,800 million without Sotuba and MF7,110 million with Sotuba. The rate of return for 1968/69 can therefore be estimated at 19.4 percent without Sotuba and 7.6 percent with Sotuba. In view of substantial financing provided by third parties (customer contributions) and by subventions, such a rate of return can be considered reasonable.

63. The major problem, however is the accounts receivable with a cumulative total on June 30, 1968 of MF1,001.7 million, corresponding to about 84 percent of 1967/68 revenues. The major debtors are the Municipalities of Bamako and Kayes whose debts total about MF300 million.

64. Since EdF is presently studying EDM's management and organization, in particular the accountancy system and procedures, state of existing accounts, metering, billing and collection procedures, procedures for dealing with arrears, stores management, balance sheet, etc., the above information is preliminary only and subject to revision after review of EdF's study and recommendations.

C. Tariffs

65. The tariffs in force up to nine months after the devaluation of the Mali Franc were:

| | | | |
|---------------------|---|---------|------------------------|
| High Tension Sales: | Annual charge per kW installed | MF5,760 | US\$23.0 ^{1/} |
| | Energy charge per kWh | | |
| | Peak hours | MF33 | UScents 13.2 |
| | Intermediate hours | MF24 | UScents 9.6 |
| | Night hours | MF18 | UScents 7.2 |
| | or One-tariff system (for an installed capacity equal or smaller than 25 kW) per kWh consumed | MF33 | UScents 13.2 |
| Low Tension Sales: | <u>Lighting and Domestic</u> | | |
| | The first 30 hours per month times installed capacity, per kWh | MF40 | UScents 16.0 |
| | The following 30 hours, per kWh | MF36 | UScents 14.4 |
| | Above 60 hours, per kWh | MF26 | UScents 10.4 |
| | <u>Public Lighting</u> | | |
| | The first 120 hours per month times installed capacity, per kWh | MF36 | UScents 14.4 |
| | Above 120 hours, per kWh | MF24 | UScents 9.6 |

^{1/} US equivalents pre-devaluation exchange rate MF250 = US\$1

Power

| | | |
|------------------------------------|---------|--------------|
| a) Annual charge per kWh installed | MF5,760 | US\$23.0 |
| Energy charge per kWh | | |
| Peak hours | MF36 | UScents 14.4 |
| Intermediate hours | MF30 | UScents 12.0 |
| Night hours | MF24 | UScents 9.6 |
| b) One-tariff system, per kWh | MF36 | UScents 14.4 |

66. For hire and maintenance of meters, the monthly rent charged varies according to number of phases, installed capacity and voltage served. For a 3-amperes one-phase meter serving an installed capacity of 380 Watts at 127/220 Volts the monthly rent is MF 30 and for a 100-amperes three-phase meter serving an installed capacity of 66 kw at 220/380 Volts, MF3,800.

67. The above electricity tariffs do not include any surcharges and taxes to be paid by the customer etc. Tariffs are fixed by the Government in consultation with the concerned Ministries. They can vary with the economic situation and can be revised every five years. If the economic index increases to 3/2 or decreases to 2/3 of the value at the time of the last tariff revision, EDM or the Government may request revision. Tariffs may also be revised if i) the sales of the last year are three times the sales of the year when the tariffs were last determined; ii) new means of generation, transmission or distribution are used which would materially affect existing tariffs; and iii) if during the period of the concession the Government places at EDM's disposal hydro energy or if the tariffs for the sale of such energy to EDM are revised.

68. The above tariff schedule is still in force. As a result of devaluation, electricity bills issued after January 1968 have been increased by a surcharge of 47 percent. In addition the Government collects from the consumer a tax of MF2.0 per kWh consumed.

D. Taxes

69. EDM is subject to all taxes established by the Republic of Mali and by the Municipalities. These, with the exception of a surcharge and taxes to be paid by the consumer, are included in the tariff structure. Should the taxes change, EDM and the Government have the right to request a tariff revision.

E. Consumers

70. EDM presently serves about 14,300 electricity consumers as shown below:

| | |
|------------|---------------|
| Bamako | 9,419 |
| Kayes | 1,176 |
| Gao | 668 |
| Mopti | 1,067 |
| Segou | 1,423 |
| Bougouni | n.a. |
| Sikasso | 296 |
| Tombouctou | 262 |
| Total | <u>14,311</u> |

VIII. CONCLUSIONS

71. The present power market and its past development reflects the economic situation of Mali. The modern sector is limited and only 10 percent of Mali's population lives in towns with more than 5,000 inhabitants. With an estimated population of 4.9 million inhabitants in 1968 - about 2 percent population growth per annum assumed - per capita energy consumption in 1968 was only about 7 kWh, which is low even for African conditions.

72. The average annual growth rate was 10.3 percent for 1962-68 or only 6.3 percent for 1965-68. These growth rates are small for a developing country and are due not only to prevailing economic conditions but also reflect

- i) EDM's financial situation and difficulty in obtaining financial assistance for expansion projects; and
- ii) EDM's past financing methods, whereby distribution extensions are largely financed by customer contributions.

73. There is a considerable potential demand for electricity, especially in Bamako, but consumers, although able to pay for consumption, do not necessarily have the means to finance the required distribution extensions.

74. The study being carried out by IGECO/EdF will assist EDM to prepare long-range expansion and investment programs and will permit EDM, by implementing recommendations made, to reorganize and meet future requirements in a rational and economical manner. The tentative investment program prepared for 1969-73, though reasonable, covers only immediate needs.

75. The next major power project in Mali, the Selingué project, requires further studies. In particular, economic analyses are needed since not only power but also irrigation and transportation benefits could result from the modest regularization of the Niger flow provided by the Selingué reservoir during the low flow period. A power plant at the foot of the Selingué dam is not necessarily the next power development since regularization would

improve generation and firm power capability of the existing Sotuba power plant and permit this plant to be enlarged by the addition of two more units. Nevertheless, it is likely that the most economic way to meet forecast demand in the immediate future would be an expansion of thermal facilities at Bamako and deferment of Selingué until the system has grown to absorb Selingué power. It is possible that Selingué would not be needed before 1980 at the earliest.

76. Construction of Selingué, however, is dependent on agreement being reached between Mali and Guinea since the Sankarani river near Selingué forms the border between Mali and Guinea and about 2,150 ha of Guinea territory would be flooded by the reservoir. Reducing the storage level to prevent flooding of Guinea territory would greatly affect the economic justification of the proposed scheme. It is, therefore, recommended that Mali should negotiate with Guinea i) the conditions under which Guinea territory can be flooded and, ii) the establishment of an advance flood warning system since the Sankarani catchment area lies within Guinea territory.

77. EDM's financial situation, taken as a whole, is not unreasonable, since it is estimated that the tariff adjustments, put into force following devaluation, will permit in 1968/69 a rate of return of 19.4 percent without Sotuba assets, and 7.6 percent with Sotuba assets. Equity represents about 70 percent of total liabilities, long- and medium-term debts 19 percent and current liabilities 11 percent. The ratio of current assets to current liabilities of about 3.6 is high, mainly as a result of customer receivables. Cumulatively, these represented in 1967/68 about 84 percent of total sales revenues for this particular financial year. It is recommended that agreements should be reached with the principal debtors for payment of arrears, if necessary, over an extended period. The IGECO/EdF study will cover this question and make recommendations.

78. EDM has recently obtained a supplier's credit for an addition to its Bamako thermal plant. Its most immediate requirement is now to complete financing of water distribution facilities in Bamako. Later it is likely to require further financing for another addition to thermal facilities and, perhaps, for water supply in some provincial towns.