The Federal Republic of Nigeria
Federal Ministry of Power and Steel (FMPS)
Federal Ministry of Science and Technology (FMST)
Energy Commission of Nigeria (ECN)
Rural Electrification Agency (REA)

# The Master Plan Study for Utilization of Solar Energy in the Federal Republic of Nigeria

## Final Report

## Volume 2 Main Report (Master plan)

**February, 2007**


**JAPAN INTERNATIONAL COOPERATION AGENCY**

**YACHIYO ENGINEERING CO., LTD.**

**RECS INTERNATIONAL INC.**

# THE MASTER PLAN STUDY FOR UTILIZATION OF SOLAR ENERGY IN THE FEDERAL REPUBLIC OF NIGERIA

## FINAL REPORT

## CONTENTS

# PREFACE

In response to a request from the Federal Republic of Nigeria, the Government of Japan decided to conduct "The Master Plan Study for utilization of solar energy in the federal republic of Nigeria" and entrusted to the study to the Japan International Cooperation Agency (JICA).

JICA dispatched the study team headed by Mr. Mitsuhisa NISHIKAWA of Yachiyo Engineering Co., Ltd. and organized by Yachiyo Engineering Co., Ltd. and RECS International Inc. to Nigeria six times from June 2005 to February 2007.

The study team had a series of discussions with the officials concerned of the Government of Nigeria and conducted related field surveys at the study area. Upon returning to Japan, the study team conducted further studies and compiled the final results in this report.

I hope that this report will contribute to the promotion of the plan and to the enhancement of amity between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Nigeria for their close cooperation throughout the study.

February 2007

Tadashi IZAWA
Vice President
Japan International Cooperation Agency

Mr. Tadashi IZAWA
Vice President
Japan International Cooperation Agency

# LETTER OF TRANSMITTAL

February 2007

Dear Sir
It is my great pleasure to submit herewith the Final Report of "The Master Plan Study for Utilization of Solar Energy in the Federal Republic of Nigeria".

The Study Team that consists of Yachiyo Engineering Co., Ltd. and RECS International Inc. conducted field surveys including pilot projects in Nigeria over the period between June, 2005 and February, 2007 according to the contract with the Japan International Cooperation Agency (JICA).

The Study Team compiled this report, which proposes Master Plan and Action Plan for PV Rural Electrification, Action Plan for Research and Development of Solar Energy Technology, Action Plan for Awareness Raising of Solar Energy, etc, through close consultations with officials concerned of the Government of the Federal Republic of Nigeria and other authorities concerned.

On behalf of the Study Team, I would like to express my sincere appreciation to officials concerned of the Government of Nigeria and other authorities concerned for their cooperation, assistance, and heartfelt hospitality extended to the Study Team.

We are also deeply grateful to the Japan International Cooperation Agency, the Ministry of Foreign Affairs, the Ministry of Economy, Trade and Industry, and the Embassy of Japan in Nigeria for their valuable suggestions and assistance during the course of the Study.

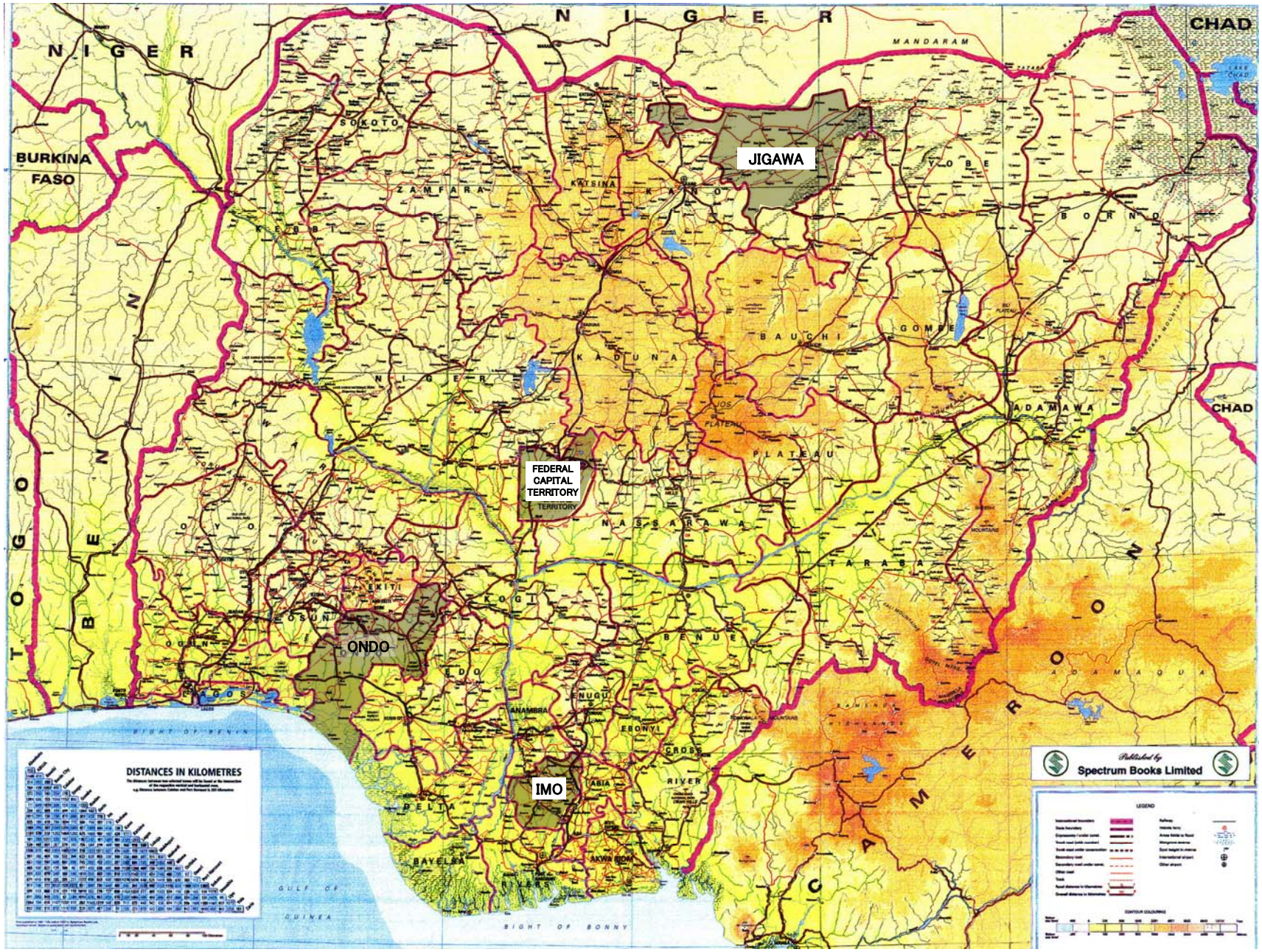
Yours faithfully,

Mitsuhisa Nishikawa
Team Leader
The Master Plan Study for
Utilization of Solar Energy in the
Federal Republic of Nigeria

# THE MASTER PLAN STUDY FOR UTILIZATION OF SOLAR ENERGY IN THE FEDERAL REPUBLIC OF NIGERIA

## FINAL REPORT
## (VOLUME 2 MAIN REPORT (MASTER PLAN))

## CONTENTS




Study Area in the Federal Republic of Nigeria

# LIST OF FIGURE

**Part 1**

**Part 2**

# LIST OF TABLE

**Part 1**

**Part 2**

# ABBREVIATION

| | |
|---|---|
| BCS | Battery Charging Station |
| BPE | Bureau of Public Enterprises |
| ECN | Energy Commission of Nigeria |
| EIA | Environmental Impact Assessment |
| ESCO | Energy Service Company |
| FCT | Federal Capital Territory |
| FMPS | Federal Ministry of Power and Steel |

(Federal Ministry of Power and Steel (FMPS) was reorganized to Federal Ministry of Energy on January 2007)

| | |
|---|---|
| FMST | Federal Ministry of Science and Technology |
| GDP | Gross Domestic Product |
| IEC | International Electrotechnical Commission |
| IPP | Independent Power Producer |
| ISO | International Organization for Standards |
| JAEF | Jigawa Alternative Energy Fund |
| JICA | Japan International Cooperation Agency |
| LGA | Local Government Area |
| LGHQ | Local Government Headquarter |
| NEEDS | National Economic Empowerment and Development Strategy |
| NEPA | National Electric Power Authority |
| NESCO | National Electricity Supply Corporation (Nigeria) Limited |
| NPC | National Planning Commission |
| O&M | Operation and Maintenance |
| OJT | On the Job Training |
| PHCN | Power Holding Company of Nigeria |
| PRSP | Poverty Reduction Strategy Paper |
| REA | Rural Electrification Agency |
| REB | Rural Electrification Board |
| REF | Rural Electrification Fund |
| REP | Rural Electrification Policy |
| SELF | Solar Electric Light Fund |
| SHS | Solar Home System |
| USAID | United States Agency for International Development |
| UNIDO | United Nations Industrial Development Organization |
| UNICEF | United Nations Children’s Fund |

# Part 1 BASIC STUDY

# PART 1 BASIC STUDY

## Chapter 1 Introduction

### 1.1 Background and History of the Study

In the Federal Republic of Nigeria (hereinafter referred to as "Nigeria"), some 60% of the people currently lack access to electricity. In rural areas in particular where some 70% of the total population live, some 90% live without electricity. This lack of electricity has many negative impacts on the lives of people, including inability to store vaccines and drugs in a cool place and inability to thresh harvested agricultural crops in addition to progressive forest destruction due to dependence on firewood as the main source of energy in rural areas.

To improve the situation, the Government of Nigeria has been making conscious efforts to build a new power station and to expand/repair existing power stations as well as the transmission and distribution grid via the Federal Ministry of Power and Steel (FMPS), which is the competent ministry for the power sector, and Power Holding Company of Nigeria (PHCN). However, the actual progress has substantially fallen behind that planned because of insufficient budget and manpower. In remote villages which are located far from the existing distribution grid and which have a low density of demand for electricity, electrification by means of distribution line extension (grid electrification) is economically difficult, making the strategic introduction of off-grid electrification using dispersed power generation essential.

For this reason, the Government of Nigeria is examining an energy supply programme through the spread of dispersed power generation using renewable energies for remote rural areas which are likely to be left behind conventional grid electrification for the medium to long-term. In regard to solar energy (including the use of solar heat) in particular, not only the FMPS but also the Federal Ministry of Science and Technology (FMST) and the Energy Commission of Nigeria (ECN), a subordinate organization of the FMST, are planning its introduction and technical R & D and extension activities on the use of solar energy are in progress at research facilities in Sokoto and Enugu States. At present, however, the FMPS, FMST and ECN are independently implementing their own pilot projects for the introduction of solar energy and a cross-ministerial approach based on the adoption of a master plan is essential to realise an electrification programme using solar energy for remote rural areas. Meanwhile, the Electric Power Sector Reform Bill prepared by the Bureau of Public Enterprises with the assistance of the World Bank was approved by President Obasanjo in March, 2005 and the Rural Electrification Agency (REA) was set up in March, 2006 as an agency responsible for rural electrification independently from the government. As part of the reform of the power sector, the Nigerian Electricity Regulatory Commission (NERC) has also been set up, illustrating the major changes of the situation surrounding the use of solar energy and rural electrification projects.

In February, 2004, the Government of Nigeria made a request to the Government of Japan to conduct the M/P Study for the Use of Solar Energy (hereinafter referred to as "the Study") to further

facilitate efforts to introduce solar energy in view of the changing circumstances. In response, the JICA conducted the Project Formulation Study for Mining and Manufacturing Industries in September, 2004 and the Preliminary Study in January, 2005 and agreed the basic plan for the project with the Nigerian side. The Study is based on the Scope of Work (S/W) signed on 6th April, 2005 and the Minutes of Meetings (M/M) signed on 7th September, 2004, 25th January, 8th July and 10th October, 2005. The Study has been conducted based on the contents, division of work between the Japanese side and its Nigerian counterpart and the schedule, etc. specified in these documents.

## 1.2 Purpose of the Study

The Study intends to strengthen the capacity of the Nigerian organizations (REA, FMPS, FMST, ECN and state governments, etc.) which play a principal role in the promotion of the use of solar energy by means of preparing measures for the Government of Nigeria for the promotion of the use of solar energy through the formulation of a master plan for the use of solar energy (hereinafter referred to as "the M/P) and various recommendations. The results of the Study will be those listed below.

(1) Master Plan for Rural Electrification Using Solar Energy
(2) Action Plan for R & D on Solar Energy Technologies
(3) Action Plan for Education on and Dissemination of the Use of Solar Energy

## 1.3 Study Area

The Study Area covers entire Nigeria. However, the Pre-Feasibility Study (Pre-F/S) will only be conducted in Jigawa State, Ondo State and Imo State as well as Abuja Federal Capital Territory while the pilot project will be conducted in Jigawa State, Ondo State and Imo State (added by the M/M signed on 10th October, 2005).

## 1.4 Basic Policies of the Study

### (1) Viewpoint for Technology Transfer

The Study is not simply designed to produce a final report but has the principal purpose of assisting capacity development (CD) for the promotion of the use of solar energy by organizations (such as the REA, FMPS, FMST, ECN and state governments) which play a leading role in the promotion of the use of solar energy. For this reason, the Joint Coordinating Committee (JCC) [1)] and the Joint Work Group (JWG) [2)] were formed and functioned throughout the field survey period. As a result, it was possible for them to act as the counterparts for the technology transfer under the Study, including the planning and monitoring of the pilot project, the implementation of the Pre-F/S, education and extension activities and guidance on R & D activities, etc. Moreover, it was recommended that the separate roles to be played by the REA set up in March, 2006 and other organizations (FMPS, FMST and ECN, etc.) should be clearly established and that the JWG should act as a coordinating body to

1) Joint Coordinating Committee: The committee was set up to ensure the smooth progress and coordination of the Study with the head of a FMPS bureau acting as the chairperson of the JCC and assuming overall responsibility for the project.
2) Joint Work Group: Subordinate body of the JCC and responsible for practically ensuring the smooth implementation of the daily work. The head of a FMPS section was selected as the group leader.

ensure the consistent promotion of the introduction of solar energy.

In the course of the Study, measuring technologies mainly to check the equipment performance were transferred for the purpose of enabling research institutions in Nigeria to independently conduct the R & D of equipment to use solar energy. The PDCA cycle of such R & D activities is shown in Fig. 1-1. As no measuring technologies to check the performance of trial equipment existed in Nigeria, R & D activities were only at the second stage (D) at the time of the Study's commencement. The principal aim of the transfer of measuring and evaluation technologies under the Study was completion of the first PDCA cycle as such transfer and recommendations based on the check (evaluation) results would enable a move from Do to Check (as shown by arrow ② in Fig. 1-1) and a move from Check to Action (as shown by arrow ③ in Fig. 1-1) respectively. As part of the Study, a R & D action plan was formulated and capacity development work with emphasis on the process from check/analysis to the planning of improvement measures was conducted so that the Nigerian side can perform the second PDCA cycle onwards without external assistance.

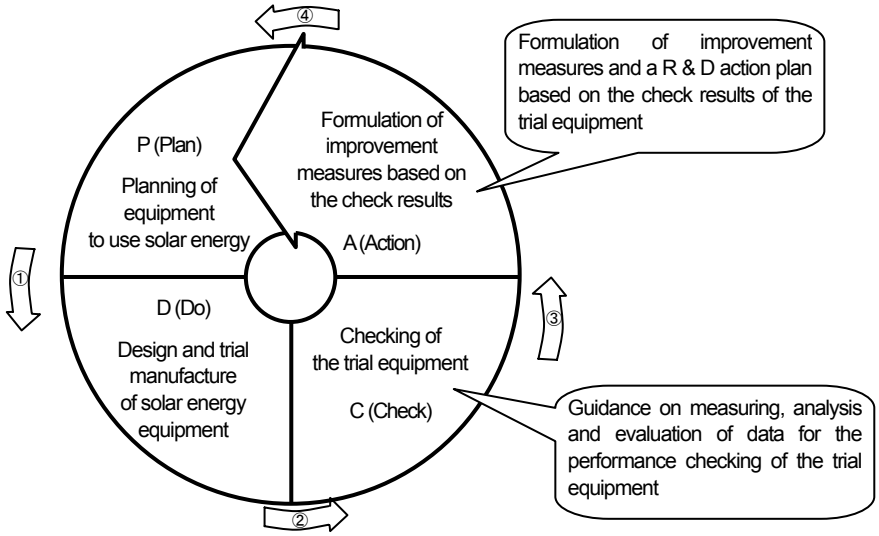



**Fig. 1-1 PDCA Cycle for R & D of Solar Energy Technologies**

During the study period, counterpart training was conducted in Japan for eight trainees from Nigeria from 29th November to 14th December, 2005 (13 days). This training included visits to observe PV panel manufacturing lines at factories of Sharp and Kyocera in addition to lectures, exercises and the exchange of opinions to enable the trainees to independently solve problems on their return to Nigeria.

**(2) Planning of the Pilot Project and Feedback Through Monitoring**

During the course of the Study, the pilot project was implemented in Jigawa State, Ondo State and Imo State. The basic components of this pilot project were battery charging stations (BCS), solar home system (SHSs), public facilities and street lamps. For the planning and implementation of the pilot project, the participatory development technique was employed. Resident meetings were held at state government offices as well as at the project sites to eradicate any psychological unease among the residents and also to enable the beneficiaries to understand the technical limitations of a renewable

energy. After commencement of the operation of the PV system, operation and maintenance data were recorded for the assessment of sustainable maintenance and the assessment results which will provide useful references for similar projects in the future were incorporated in the M/P. Furthermore, separate maintenance manuals were prepared for engineers, maintenance staff and users to support a cross-sectional maintenance system after equipment installation. The contents of these manuals were explained to the counterparts.

**(3) Proposal of Business Models Reflecting the Local Characteristics**

For the formulation of a national level PV electrification plan, the implementation of multiple business models to satisfy the demand for PV electrification in each area is essential instead of the application of a single business model nationwide given the geographical expanse of Nigeria and the level of autonomy of each state or geopolitical zone. Because of (i) the Nigerian practice of giving the priority for grid electrification to areas where both the power demand density and the potential level of payment of the electricity charge are high and (ii) the difficulty of extracting uniform indicators for the comparison of different states, the existing electrification rate was used for the Study to classify the entire country into the following three models. A nationwide PV electrification plan was then formulated by predicting the quantity of PV equipment to be introduced for each model.

① **Electrification Model A (Jigawa State Model):**
**States with an electrification rate of less than 30%**
In the short-term (up to 2010), priority will be given to the introduction of PV systems for public facilities and BCSs. Further BCSs and SHSs will be introduced at the stage where there is widespread use of PV equipment (2010 – 2020).

② **Electrification Model B (Imo State Model):**
**States with an electrification rate of 30% or higher but less than 70%**
In the short-term (up to 2010), priority will be given to the introduction of SHSs, followed by the introduction of a mini-grid system at the stage where there is widespread use of PV equipment (2010 – 2020).

③ **Electrification Model C (Ondo State, FCT Model):**
**States with an electrification rate of 70% or higher**
A mini-grid system will be introduced in both the short-term (up to 2010) and medium to long-term (2010 – 2020).

The reasons for the proposal of the above three models are given below.

- In states with a low electrification rate, the possibility of extension of the existing grid to the target villages for electrification in the near future is low because of the long average distance from the grid to these villages. This makes the potential for the introduction of a PV system high. However, given the low level of the electricity charge payment capacity, the introduction of a system of which the equipment cost, maintenance cost and charge level are lower than those of a PV system is desirable.

- In states with a high electrification rate, the introduction of a mini-grid system is possible because of the short average distance from the existing grid to the target villages for electrification, the possibility of grid extension in the near future and the relatively high electricity charge payment capacity. Such a mini-grid system can be incorporated when a distribution line is extended from the existing grid.

## 1.5 Formulation Process of the M/P

A rural PV electrification plan up to 2020 targeting entire Nigeria and four states (Jigawa, Ondo, Imo and Capital Territory) was formulated under the Study for the purpose of encouraging the governments of these four states and the REA to promote this rural PV electrification plan based on their own initiative. Fig. 1-2 shows the formulation process of the rural electrification plan using a PV system which is described in this Summary and in more detail in the main report.

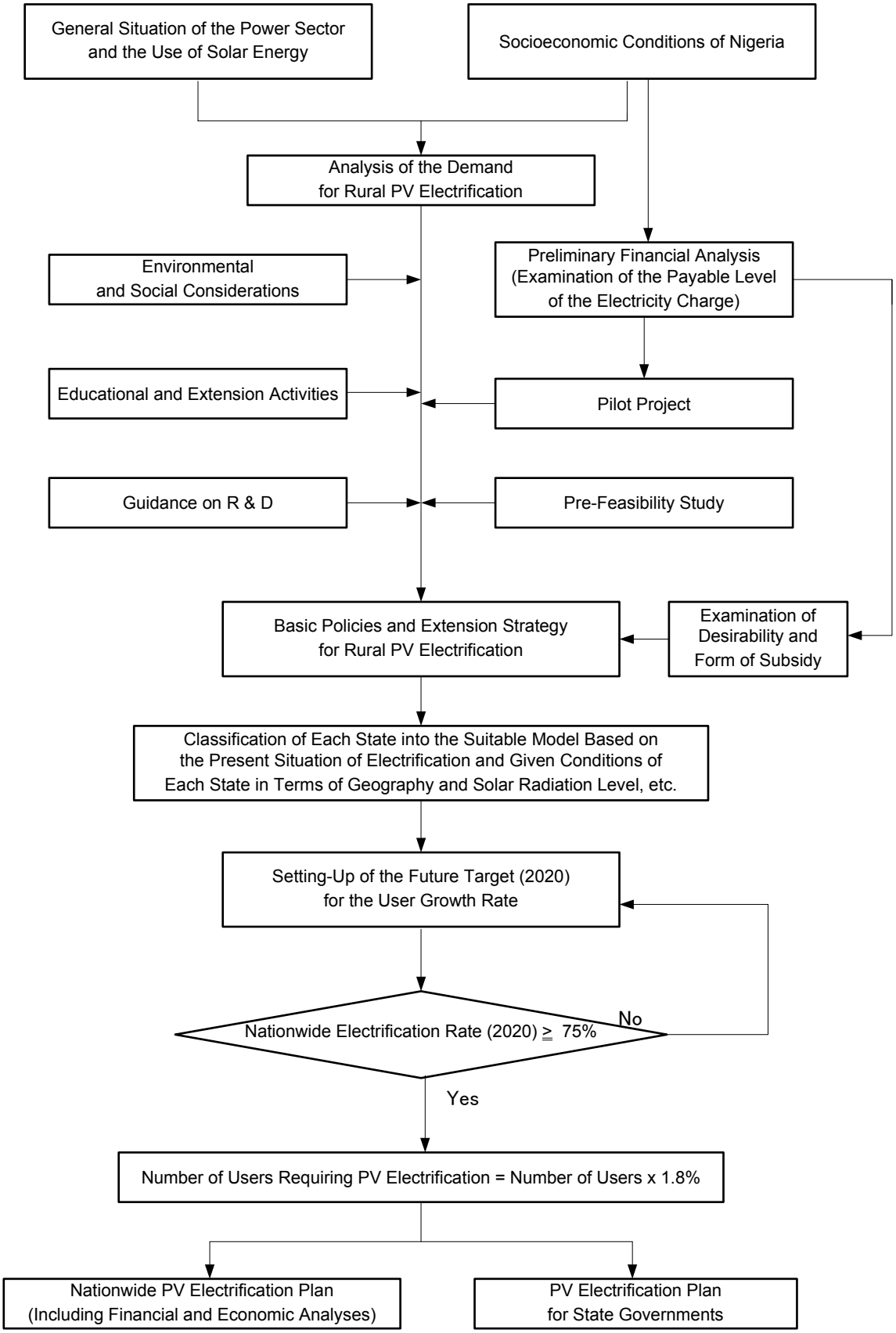



**Fig. 1-2 Formulation Process of the M/P**

# Chapter 2 Socio-economic Conditions and Electricity Demand in Nigeria

## 2.1 Socio-economic Conditions in Nigeria

### 2.1.1 General

Nigeria has gained its independence from Britain in 1960. Following nearly 16 years of military rule, a new constitution was adopted in 1999, and in May of 1999, the democratically elected government of President Olusegun Obasanjo assumed power, and was then re-elected to a second term in May 2003. In recent years, Nigeria's international standing has increased as the country moved from dictatorship to democracy and started implementing economic reforms. President Obasanjo is the chair of the African Union (AU), and Nigeria is a leading player in the Commonwealth, in the New Partnership for Africa's Development (NEPAD), and in the Economic Community of West African States (ECOWAS).

Nigeria is divided into six (6) geopolitical zones as shown in Table 2.1. There are 36 states and Federal Capital Territory (FCT) in Nigeria, and they are made up administrative units, called Local Governments (in 36 states) or Area Councils (in FCT) respectively.

**Table 2-1 Geopolitical Zones**

| Geopolitical Zone | Contained states | |
|---|---|---|
| South West (SW) | Ekiti, Lagos, Osun, Ondo, Ogun, Oyo | : 6 states |
| South East (SE) | Abia, Anambra, Ebonyi, Enugu, Imo | : 5 states |
| South South (SS) | Akwa-Ibom, Bayelsa, Cross-River, Delta, Edo, Rivers | : 6 states |
| North Central (NC) | Benue, FCT, Kogi, Kwara, Nassarawa, Niger, Plateau | : 6 states and FCT |
| North East (NE) | Adamawa, Bauchi, Borno, Gombe, Taraba, Yobe | : 6 states |
| North West (NW) | Kaduna, Katsina, Kano, Kebbi, Sokoto, Jigawa, Zamfara | : 7 states |

### 2.1.2 Population

A census was conducted in 1991 and the total population of Nigeria in 1991 was 88,992 thousand according to the census rsults. Table 2-4 shows the distribution of the state population among states and FCT. Table 2-5 shows the population projection. There were 30 states and FCT in 1991. The number of states increased after that by dividing some states into two states respectively as shown below, and there are 36 states and FCT at present.

**Table 2-2 Divided states**

| Name of state in 1991 | Name of state after division |
|---|---|
| Bauchi | Bauchi, Gombe |
| Enugu | Enugu, Enonyi |
| Ondo | Ondo, Ekiti |
| Plateau | Plateau, Nasarawa |
| Rivers | Rivers, Bayelsa |
| Sokoto | Sokoto, Zamfara |

The average population density for the country in 1991 was 105 persons per $km^2$. An urban centre is defied as a settlement with 20,000 inhabitants or more by the 1991 Census. At the national level, the proportion of the population living in urban areas was about 36% according to this definition.

Apart from the 1952/53, all the colonial period censuses were based on informed estimate, rather than actual field enumeration. The total population from the respective censuses and the intercensal growth rates are presented in Table 3.3. The growth rates were computed using the exponential growth method. The growth rate of 2.8 % for the thirty nine year period 1952/53 to 1991 is the closest to the expected growth rates for Nigeria.

**Table 2-3 Census population and intercensal growth rate**

| Census Year | Population (million) | Period (years) | | Growth rate (%) | |
|---|---|---|---|---|---|
| | | Intercensal | From 1953 | Intercensal | From 1953 |
| 1911 | 16.05 | - | - | - | - |
| 1921 | 18.72 | 10 | - | 1.54 | - |
| 1931 | 20.06 | 10 | - | 0.69 | - |
| 1952/53 | 30.42 | 22 | 0 | 1.89 | - |
| 1963 | 55.66 | 10 | 10 | 6.04 | 6.04 |
| 1973 | 79.76 | 10 | 20 | 3.60 | 4.82 |
| 1991 | 88.99 | 18 | 38 | 0.61 | 2.82 |

Source: 1962/63 Census Nigeria, 1991 Population Census

Nigeria's population is made up of about 250 ethnic groups. The largest ones are the Hausa-Fulani (29%) in the north, he Yoruba (21%) in the southwest and Igbo (or Ibo, 18%) in the southeast. The following major groups are Ijaw（10%）, Kanuri（4%）, Ibibio（3.5%） and Tiv (2.5%). There are around 350 indigenous languages as shown in Table 2.4. Religions are Islam (50%), Christianity (40%) and indigenous beliefs (10%).

**Table 2-4 Population, Household and Language in Each State**

| No. | State | Population | Area (km2) | Population Density | Number of Households | Average household size | Urban population (%) | No. of Spoken Language |
|---|---|---|---|---|---|---|---|---|
| 1 | Abia | 2,338,487 | 6,420 | 364 | 508,874 | 4.6 | 37.8 | 1 |
| 2 | Adamawa | 2,102,053 | 35,470 | 59 | 405,495 | 5.2 | 22.5 | 18 |
| 3 | Akwa-Ibom | 2,409,613 | 6,187 | 389 | 471,747 | 5.1 | 12.1 | 13 |
| 4 | Anambra | 2,796,475 | 5,235 | 534 | 584,996 | 4.8 | 61.9 | NA |
| 5 | Bauchi | 4,351,007 | 64,605 | 67 | 771,880 | 5.6 | 16.1 | 15 |
| 6 | Bayelsa | — | — | — | — | – | - | 11 |
| 7 | Benue | 2,753,077 | 32,910 | 84 | 496,665 | 5.5 | 16.5 | 7 |
| 8 | Borno | 2,536,003 | 71,130 | 36 | 559,481 | 4.5 | 35.6 | 22 |
| 9 | Cross River | 1,911,297 | 21,050 | 91 | 391,286 | 4.9 | 25.1 | 39 |
| 10 | Delta | 2,590,491 | 18,050 | 144 | 571,306 | 4.5 | 33.2 | 9 |
| 11 | Ebonyi | — | — | — | — | – | - | 5 |
| 12 | Edo | 2,172,005 | 17,450 | 124 | 440,354 | 4.9 | 45.4 | 13 |
| 13 | Ekiti | — | — | — | — | – | - | 2 |
| 14 | Enugu | 3,154,380 | 12,440 | 254 | 636,107 | 5.0 | 41.6 | 1 |
| 15 | Gombe | — | — | — | — | – | - | 12 |
| 16 | Imo | 2,485,635 | 5,430 | 458 | 539,326 | 4.6 | 32.7 | NA |
| 17 | Jigawa | 2,875,525 | 22,605 | 127 | 569,738 | 5.0 | 6.9 | 1 |
| 18 | Kaduna | 3,935,618 | 43,460 | 91 | 717,810 | 5.5 | 40.8 | 23 |
| 19 | Kano | 5,810,470 | 20,680 | 281 | 1,116,558 | 5.2 | 39.9 | 1 |
| 20 | Katsina | 3,753,133 | 26,785 | 140 | 720,286 | 5.2 | 30.3 | NA |
| 21 | Kebbi | 2,068,490 | 41,855 | 49 | 380,405 | 5.4 | 12.4 | 8 |
| 22 | Kogi | 2,147,756 | 32,440 | 66 | 394,596 | 5.4 | 35.3 | 14 |
| 23 | Kwara | 1,548,412 | 37,700 | 41 | 325,625 | 4.8 | 42.8 | 3 |
| 24 | Lagos | 5,725,116 | 3,345 | 1,712 | 1,281,600 | 4.5 | 93.7 | 2 |
| 25 | Nassarawa | — | — | — | — | – | - | 21 |
| 26 | Niger | 2,421,581 | ,13,930 | 174 | 452,596 | 5.4 | 22.8 | 22 |
| 27 | Ogun | 2,333,726 | 16,762 | 139 | 576,564 | 4.0 | 44.8 | 5 |
| 28 | Ondo | 3,785,338 | 20,959 | 181 | 818,992 | 4.6 | 40.4 | 3 |
| 29 | Osun | 2,158,143 | 10,245 | 211 | 484,371 | 4.5 | 55.5 | 1 |
| 30 | Oyo | 3,452,720 | 27,460 | 126 | 766,652 | 4.5 | 69.3 | NA |
| 31 | Plateau | 3,312,412 | 58,030 | 57 | 575,777 | 5.8 | 25.0 | 32 |
| 32 | Rivers | 4,309,557 | 21,850 | 197 | 812,463 | 5.3 | 31.4 | 21 |
| 33 | Sokoto | 4,470,176 | 60,780 | 74 | 894,287 | 5.0 | 13.5 | 2 |
| 34 | Taraba | 1,512,163 | 55,920 | 27 | 271,092 | 5.6 | 10.4 | 16 |
| 35 | Yobe | 1,399,687 | 45,270 | 31 | 287,161 | 4.9 | 24.3 | 11 |
| 36 | Zamfara | — | — | — | — | – | - | NA |
| 37 | Abuja | 371,674 | 7,315 | 51 | 85,615 | 4.3 | 28.9 | 1 |
| | Total | 88,992,220 | 863,768 | 103 | 17,909,705 | 5.0 | 36.3 | 354 |

Source: National Population Commission, 1991 Population Census of Nigeria
Federal Office of Statistics, Annual Abstract of Statistics 2001 Edition
Remark: The shaded columns show the target states of the Project.

**Table 2-5 Projected Population (Medium Variant)**

| No. | State | 2006 | 2007 | 2008 | 2009 | 2010 |
|---|---|---|---|---|---|---|
| 1 | Abia | 2,963,275 | 3,051,841 | 3,142,333 | 3,234,713 | 3,328,943 |
| 2 | Adamawa | 3,254,791 | 3,352,085 | 3,451,493 | 3,552,978 | 3,656,494 |
| 3 | Akwa-Ibom | 3,730,227 | 3,841,712 | 3,955,620 | 4,071,906 | 4,190,521 |
| 4 | Anambra | 4,329,820 | 4,459,236 | 4,591,465 | 4,726,455 | 4,864,146 |
| 5 | Bauchi | 4,431,424 | 4,563,897 | 4,699,251 | 4,837,433 | 4,978,375 |
| 6 | Bayelsa | 1,737,020 | 1,788,957 | 1,860,024 | 1,896,199 | 1,951,456 |
| 7 | Benue | 4,262,764 | 4,390,184 | 4,520,375 | 4,653,283 | 4,788,852 |
| 8 | Borno | 3,926,963 | 4,044,366 | 4,164,321 | 4,286,781 | 4,411,691 |
| 9 | Cross River | 2,959,896 | 3,048,375 | 3,138,777 | 3,231,068 | 3,325,205 |
| 10 | Delta | 4,010,879 | 4,130,761 | 4,253,249 | 4,378,294 | 4,505,843 |
| 11 | Ebonyi | 2,250,677 | 2,317,922 | 2,386,630 | 2,456,772 | 2,528,319 |
| 12 | Edo | 3,363,098 | 3,463,629 | 3,566,346 | 3,671,207 | 3,778,167 |
| 13 | Ekiti | 2,377,929 | 2,449,007 | 2,521,630 | 2,595,769 | 2,671,391 |
| 14 | Enugu | 3,289,864 | 3,388,168 | 3,488,610 | 3,591,150 | 3,695,743 |
| 15 | Gombe | 2,305,771 | 2,374,698 | 2,445,125 | 2,517,021 | 2,590,356 |
| 16 | Imo | 3,848,056 | 3,963,039 | 4,080,523 | 4,200,459 | 4,322,798 |
| 17 | Jigawa | 4,452,585 | 4,585,695 | 4,721,699 | 4,860,541 | 5,002,162 |
| 18 | Kaduna | 6,094,506 | 6,276,729 | 6,462,915 | 6,652,985 | 6,846,859 |
| 19 | Kano | 8,997,330 | 9,266,314 | 9,541,146 | 9,821,715 | 10,107,898 |
| 20 | Katsina | 5,811,165 | 5,984,866 | 6,162,344 | 6,343,527 | 6,528,336 |
| 21 | Kebbi | 3,202,837 | 3,298,579 | 3,396,402 | 3,496,268 | 3,598,132 |
| 22 | Kogi | 3,325,256 | 3,424,637 | 3,526,178 | 3,629,839 | 3,735,575 |
| 23 | Kwara | 2,397,533 | 2,469,200 | 2,542,427 | 2,617,181 | 2,693,431 |
| 24 | Lagos | 8,865,999 | 9,131,112 | 9,401,990 | 9,678,521 | 9,960,584 |
| 25 | Nassarawa | 1,870,248 | 1,926,153 | 1,983,274 | 2,041,588 | 2,101,069 |
| 26 | Niger | 3,749,912 | 3,862,030 | 3,976,587 | 4,093,535 | 4,212,821 |
| 27 | Ogun | 3,613,345 | 3,721,345 | 3,831,695 | 3,944,347 | 4,059,255 |
| 28 | Ondo | 3,483,147 | 3,587,265 | 3,693,648 | 3,802,251 | 3,913,027 |
| 29 | Osun | 3,341,326 | 3,441,186 | 3,543,216 | 3,647,378 | 3,753,624 |
| 30 | Oyo | 5,346,017 | 5,505,815 | 5,669,086 | 5,835,766 | 6,005,783 |
| 31 | Plateau | 3,258,658 | 3,356,070 | 3,455,599 | 3,557,205 | 3,660,845 |
| 32 | Rivers | 4,936,589 | 5,084,192 | 5,235,005 | 5,388,965 | 5,546,005 |
| 33 | Sokoto | 3,711,425 | 3,822,365 | 3,935,716 | 4,051,435 | 4,169,469 |
| 34 | Taraba | 2,341,448 | 2,411,441 | 2,482,957 | 2,555,966 | 2,630,436 |
| 35 | Yobe | 2,167,389 | 2,232,186 | 2,298,392 | 2,365,981 | 2,434,921 |
| 36 | Zamfara | 3,209,910 | 3,305,851 | 3,403,878 | 3,503,952 | 3,606,029 |
| 37 | FCT | 575,666 | 592,886 | 610,480 | 628,441 | 646,761 |
| | Total | 137,794,745 | 141,913,794 | 146,140,406 | 150,418,875 | 154,801,322 |

Source: National Population Commission (National and State Population Projections, 2002)

### 2.1.3 Education and literacy rate

Table 2-6 shows the net primary enrolment rate by state sorted by male's enrolment rate. The higher ranked states are all occupied by the southern states except Kogi (NC) ranked as 11th, and the lower ranked states are all northern states. Out of the northern states the states from North Central (NC) have higher rates. Table 2-7 shows the adult literacy rate. The trend is the same as the Table 2-6, though FCT (14th) and Kogi (16th) are relatively highly ranked.

**Table 2-6 Net Primary Enrolment Rate, 2004**

| No. | Zone * | State | Male | Female |
|---|---|---|---|---|
| 1 | SW | Lagos | 100.0 | 100.0 |
| 2 | SS | Akwa-Ibom | 99.6 | 93.1 |
| 3 | SE | Anambra | 99.1 | 98.9 |
| 4 | SW | Ondo | 98.5 | 100.0 |
| 5 | SE | Imo | 98.3 | 98.3 |
| 6 | SE | Abia | 98.1 | 98.1 |
| 7 | SS | Rivers | 97.5 | 97.9 |
| 8 | SW | Ekiti | 97.4 | 96.8 |
| 9 | SS | Edo | 97.4 | 96.4 |
| 10 | SS | Bayelsa | 95.7 | 96.5 |
| 11 | NC | Kogi | 95.2 | 97.0 |
| 12 | SE | Ebonyi | 94.6 | 88.2 |
| 13 | SE | Enugu | 94.1 | 89.6 |
| 14 | SS | Delta | 93.9 | 96.9 |
| 15 | SS | Cross River | 93.9 | 92.4 |
| 16 | SW | Ogun | 92.9 | 92.7 |
| 17 | SW | Oyo | 91.4 | 87.4 |
| 18 | SW | Osun | 91.4 | 87.4 |
| 19 | NC | Plateau | 88.6 | 78.2 |
| 20 | NC | Benue | 87.7 | 82.3 |
| 21 | NC | FCT | 85.7 | 90.5 |
| 22 | NC | Kwara | 85.7 | 87.5 |
| 23 | NE | Taraba | 77.4 | 77.4 |
| 24 | NW | Kano | 77.0 | 71.0 |
| 25 | NC | Nassarawa | 74.8 | 68.9 |
| 26 | NE | Adamawa | 73.2 | 74.5 |
| 27 | NW | Kaduna | 72.4 | 72.7 |
| 28 | NW | Zamfara | 71.5 | 68.4 |
| 29 | NW | Katsina | 66.9 | 62.8 |
| 30 | NC | Niger | 60.4 | 55.4 |
| 31 | NW | Kebbi | 59.1 | 48.3 |
| 32 | NE | Yobe | 59.0 | 50.4 |
| 33 | NW | Sokoto | 57.8 | 57.3 |
| 34 | NE | Gombe | 57.6 | 61.8 |
| 35 | NE | Bauchi | 56.7 | 56.2 |
| 36 | NE | Borno | 47.6 | 49.8 |
| 37 | NW | Jigawa | 46.0 | 37.0 |
| | | Nigeria | 82.2 | 80.2 |

**Table2-7 Adult literacy rate of those who can read and write in English, 2004**

| No. | | State | Male | Female |
|---|---|---|---|---|
| 1 | SW | Lagos | 82.5 | 65.2 |
| 2 | SE | Abia | 78.9 | 62.2 |
| 3 | SE | Imo | 77.4 | 62.3 |
| 4 | SS | Delta | 76.3 | 58.4 |
| 5 | SS | Edo | 76.1 | 58.0 |
| 6 | SS | Akwa-Ibom | 75.2 | 60.9 |
| 7 | SS | Rivers | 71.7 | 62.9 |
| 8 | SS | Cross River | 70.2 | 47.8 |
| 9 | SS | Bayelsa | 67.6 | 51.1 |
| 10 | SE | Enugu | 67.5 | 52.4 |
| 11 | SE | Anambra | 66.3 | 59.4 |
| 12 | SW | Ekiti | 64.5 | 51.3 |
| 13 | SW | Osun | 64.2 | 45.0 |
| 14 | NC | FCT | 62.9 | 53.1 |
| 15 | SE | Ebonyi | 62.5 | 45.3 |
| 16 | NC | Kogi | 62.1 | 37.9 |
| 17 | SW | Oyo | 58.4 | 45.5 |
| 18 | NC | Benue | 56.0 | 37.8 |
| 19 | SW | Ondo | 55.7 | 46.7 |
| 20 | SW | Ogun | 53.5 | 34.7 |
| 21 | NW | Kaduna | 51.6 | 36.1 |
| 22 | NC | Nassarawa | 50.9 | 22.1 |
| 23 | NC | Kwara | 49.3 | 39.1 |
| 24 | NE | Adamawa | 44.5 | 28.4 |
| 25 | NE | Taraba | 44.2 | 16.2 |
| 26 | NC | Plateau | 42.1 | 32.7 |
| 27 | NW | Kano | 33.7 | 15.6 |
| 28 | NC | Niger | 33.2 | 18.1 |
| 29 | NE | Borno | 32.1 | 17.4 |
| 30 | NE | Gombe | 31.4 | 20.2 |
| 31 | NE | Yobe | 24.0 | 16.0 |
| 32 | NW | Katsina | 19.5 | 15.0 |
| 33 | NE | Bauchi | 17.5 | 12.4 |
| 34 | NW | Kebbi | 15.2 | 3.7 |
| 35 | NW | Zamfara | 14.8 | 5.2 |
| 36 | NW | Jigawa | 12.1 | 4.4 |
| 37 | NW | Sokoto | 11.5 | 7.9 |
| | | Nigeria | 50.7 | 37.8 |

* Zone: Zone is based on the geopolitical zoning in Table 2.1.
Source: National Bureau of Statistics (The Nigerian Statistical Fact Sheets, June 2005

### 2.1.4 Living standard

Table 2-8 shows the average household income (1998/99), sorted by average per capita household income. Lagos is ranked as the 1st, followed by FCT. The southern states occupy the higher ranks and northern states lower ranks generally, though the many states of North Central (NC) are ranked middle. Table 2-9 shows poverty incidents, and it also shows the same tendency, though Table 2-8 and Table 2-9 are prepared based on the different sources respectively.

**Table 2-8 Average per capita Household Income**

| No. | | State | Average Household Income(N/y) | Average per capita Household Income(N/y) |
|---|---|---|---|---|
| 1 | SW | Lagos | 8,082 | 3,235 |
| 2 | NC | FCT | 7,180 | 2,326 |
| 3 | SE | Anambra | 6,730 | 2,127 |
| 4 | SS | Bayelsa | 6,829 | 2,107 |
| 5 | SS | Rivers | 6,829 | 2,107 |
| 6 | SW | Oyo | 5,889 | 1,647 |
| 7 | SE | Abia | 4,587 | 1,565 |
| 8 | SS | Delta | 4,325 | 1,524 |
| 9 | SW | Ogun | 3,023 | 1,467 |
| 10 | SS | Edo | 3,995 | 1,364 |
| 11 | SW | Ekiti | 3,863 | 1,208 |
| 12 | SW | Ondo | 3,863 | 1,208 |
| 13 | NC | Nassarawa | 5,159 | 1,194 |
| 14 | NC | Plateau | 5,159 | 1,194 |
| 15 | SW | Osun | 3,692 | 1,180 |
| 16 | NC | Kwara | 3,761 | 1,137 |
| 17 | NC | Kogi | 3,042 | 1,008 |
| 18 | SS | Akwa-Ibom | 3,644 | 989 |
| 19 | NC | Benue | 3,382 | 968 |
| 20 | SS | Cross River | 3,131 | 966 |
| 21 | NE | Adamawa | 3,249 | 963 |
| 22 | SE | Imo | 3,088 | 956 |
| 23 | NC | Niger | 3,227 | 948 |
| 24 | NW | Kaduna | 3,995 | 912 |
| 25 | NE | Taraba | 2,764 | 855 |
| 26 | NW | Sokoto | 2,260 | 728 |
| 27 | NW | Zamfara | 2,260 | 728 |
| 28 | SE | Ebonyi | 2,879 | 727 |
| 29 | SE | Enugu | 2,879 | 727 |
| 30 | NW | Kano | 3,995 | 704 |
| 31 | NE | Borno | 2,240 | 674 |
| 32 | NW | Kebbi | 2,341 | 568 |
| 33 | NE | Bauchi | 2,686 | 561 |
| 34 | NE | Gombe | 2,686 | 561 |
| 35 | NW | Katsina | 2,277 | 546 |
| 36 | NE | Yobe | 1,537 | 496 |
| 37 | NW | Jigawa | 1,729 | 429 |
| | | Nigeria | - | - |

**Table 2-9 Poverty Incidence**

| No. | | State | Poor (%) |
|---|---|---|---|
| 1 | SW | Oyo | 19.3 |
| 2 | SW | Osun | 22.7 |
| 3 | SS | Bayelsa | 26.3 |
| 4 | SE | Imo | 26.5 |
| 5 | SE | Abia | 28.0 |
| 6 | SW | Ogun | 29.8 |
| 7 | SE | Anambra | 30.4 |
| 8 | SE | Enugu | 33.9 |
| 9 | SW | Ekiti | 35.5 |
| 10 | NW | Kaduna | 37.7 |
| 11 | SW | Ondo | 41.5 |
| 12 | NC | Benue | 42.8 |
| 13 | SS | Rivers | 43.1 |
| 14 | SS | Edo | 44.3 |
| 15 | SS | Akwa-Ibom | 46.0 |
| 16 | SE | Ebonyi | 46.1 |
| 17 | NW | Kano | 46.7 |
| 18 | NC | Plateau | 46.8 |
| 19 | NC | FCT | 47.0 |
| 20 | NC | Nassarawa | 48.2 |
| 21 | NE | Borno | 48.7 |
| 22 | SS | Cross River | 51.6 |
| 23 | NE | Taraba | 54.1 |
| 24 | NC | Niger | 56.0 |
| 25 | NW | Katsina | 60.4 |
| 26 | SS | Delta | 62.3 |
| 27 | SW | Lagos | 64.1 |
| 28 | NE | Gombe | 66.3 |
| 29 | NE | Adamawa | 68.9 |
| 30 | NW | Sokoto | 70.5 |
| 31 | NW | Zamfara | 73.4 |
| 32 | NE | Bauchi | 76.5 |
| 33 | NC | Kwara | 79.9 |
| 34 | NE | Yobe | 84.1 |
| 35 | NW | Kebbi | 86.2 |
| 36 | NC | Kogi | 87.5 |
| 37 | NW | Jigawa | 89.5 |
| | | Nigeria | 51.6 |

- Source (Table 2.8) : Federal Office of Statistics (Annual Abstract of Statistics, 2001 Edition)
- Source (Table 2.9) : Draft Poverty Profile for Nigeria, 2004 (National Bureau of Statistics)

Despite of its large reserves of human and natural resources, poverty is widespread. About 52 percent of the population now falls below the poverty line. President Obasanjo's new administration is committed to its economic reform program- the National Economic Empowerment and Development Strategy (NEEDS) was launched in March 2004. NEEDS focuses on poverty reduction, wealth creation, and human development through initiatives in (a) reforming government and its institutions, (b) growing the non-oil private sector, and (c) implementing a social charter.

### 2.1.5 Economic activities

Nigeria's economy depends heavily on the oil sector, which contributes 95 percent of export revenues, 76 percent of government revenues, and about a third of gross domestic product (GDP). Agriculture is the second largest industry, but this sector has failed to keep up with rapid population growth- Nigeria is Africa's most populous country – and the country, once a large net exporter of food, now must import food. Wholesale and retail trade is the third sector, and it occupies 15.1% of the GDP. Table 2-10 shows the GDP of respective sectors.

**Table 2-10 Gross Domestic Product at Current Basic Prices (2004)**

(Unit: Million Naira)

| Sector | Amount | % |
|---|---|---|
| **Agriculture** | **2,578,963** | **31.20** |
| Crop production | 2,155,133 | 26.08 |
| Livestock | 243,887 | 2.95 |
| Forestry | 51,658 | 0.63 |
| Fishery | 128,285 | 1.55 |
| **Mining** | **2,842,844** | **34.40** |
| Crude Petroleum & Natural Gas | 2,831,320 | 34.26 |
| Others | 11,524 | 0.14 |
| **Manufacturing** | **372,061** | **4.50** |
| Oil refining | 22,457 | 0.27 |
| Cement | 5,477 | 0.07 |
| Others | 344,127 | 4.16 |
| **Wholesale & Retail trade** | **1,250,337** | **15.13** |
| **Real estate** | **444,688** | **5.38** |
| **Transportation** | **358,373** | **4.34** |
| Road transport | 337,555 | 4.08 |
| Air transport | 3,010 | 0.04 |
| Transport services | 16,892 | 0.20 |
| Others | 916 | 0.01 |
| **Banks & Financial activities** | **102,953** | **1.25** |
| Financial institutions | 99,872 | 1.21 |
| Insurance | 3,081 | 0.04 |
| **Building & Construction** | **80,088** | **0.97** |
| **Hotel & Restaurant** | **15,649** | **0.19** |
| **Communications** | **5,050** | **0.06** |

| | | |
|---|---|---|
| Telecommunications | 2,486 | 0.03 |
| Post services | 1,155 | 0.01 |
| Broadcasting | 1,409 | 0.02 |
| **Public administration** | **82,230** | **0.99** |
| **Other services** | **131,726** | **1.59** |
| **Total** | **8,264,962** | **100.00** |

Source：The Nigerian Statistical Fact Sheets on Economic and Social Development

## 2.2 Socio-economic Conditions in 3 states and FCT

Socio-economic conditions in the target areas of the Project: Jigawa State, Ondo State, Imo States and FCT are described below.

### 2.2.1 Jigawa

The main ethnic groups are Hausa and Fulani. The state is divided into six emirates each administered by a traditional ruler called Emir. The Emirs do not exercise political power but serve as custodians of culture and advisers to the government on traditional affairs. They are quite influential in traditional matters.

As for the primary enrollment ratio, Jigawa is ranked as the lowest. According to the definition that a percentage of those persons aged 15 and above that can read and write in any language, literacy rate in Jigawa state is 37%, among the lowest in Nigeria. While 51% of the males are literate, only 22% of the females are literate, thus indicating a gender gap of almost 30 percentage points.

Agriculture is the main industry employing 49% of the workforce. Services and trade with 21% and 15% of the workforce followed. As for male, 76.5% of the workers are involved in agriculture.

With regard to fuel sources for lighting, main source is kerosene/paraffin in rural area (Table 2-11).

**Table 2-11 Percentage distribution of households by fuel for lighting**

(unit: %)

| | Kerosene/ paraffin | Mains electricity | Electricity from generator | Battery | Firewood | Total |
|---|---|---|---|---|---|---|
| Rural | 97.5 | 1.8 | 0.2 | 0.2 | 0.4 | 100.0 |
| Urban | 59.9 | 38.4 | 1.8 | 0.0 | 0.0 | 100.0 |

Source: Core Welfare Indicators Questionnaire Survey' was conducted in 2002 in Jigawa State

### 2.2.2 Ondo State

The people of the state are mostly of the Yoruba race, although other Nigerians and foreign nationals coexist peacefully in the state. The most known ethnic subgroups are the Akoko, the Akure, the ljaw (made up of Apoi and Arogbo), the lkale, the llaje, the Ondo and the Owo. Ondo state is among the richest in the federation in the variety and quality of its traditional sculpture. The primary enrolment rate is the 4th and the literacy rate is in the middle in Nigeria. Sales, agriculture and production are main industries employing 30.9%, 26.0% and 21.5% of the workforce respectively. The following data is available regarding water and electricity supply. Only 262 communities (10.0%) are supplied with water, and 191 (7.3%) with electricity as shown here.

**Table 2-12 Number of communities with water and electricity supply**

| Senatorial Districts | Local Government Area | Total Communities* | Communities with treated water supply | | Communities with electricity supply | |
|---|---|---|---|---|---|---|
| | | | Number of communities | (%) | Number of communities | (%) |
| Ondo North | Akoko North East | 12 | 6 | 50.0 | 6 | 50.0 |
| | Akoko North West | 18 | 3 | 16.7 | 17 | 94.4 |
| | Akoko South East | 8 | 6 | 75.0 | 6 | 75.0 |
| | Akoko South West | 14 | 7 | 50.0 | 9 | 64.3 |
| | Ose | 36 | 6 | 16.7 | 13 | 36.1 |
| | Owo | 188 | 18 | 9.6 | 12 | 6.4 |
| **Sub-total** | | **276** | **46** | **16.7** | **63** | **22.8** |
| Ondo Central | Akure North | 130 | 19 | 50 | 17 | 13.1 |
| | Akure South | 125 | 8 | 6.4 | 7 | 5.6 |
| | Idanre | 108 | 20 | 18.5 | NA | − |
| | Ifedore | 157 | 31 | 19.7 | 12 | 7.6 |
| | Ondo East | 80 | 17 | 21.3 | 21 | 26.3 |
| | Ondo West | 202 | 33 | 16.3 | 2 | 1.0 |
| **Sub-total** | | **802** | **128** | **16.0** | **59** | **7.4** |
| Ondo South | Ese-odo | 243 | 5 | 2.1 | 3 | 1.2 |
| | Ilaje | 302 | 5 | 1.7 | 10 | 3.3 |
| | Ile-Oluji/Okeigbo | 320 | 56 | 17.5 | 5 | 1.6 |
| | Irele | 249 | 5 | 2.0 | 2 | 0.8 |
| | Odigbo | 328 | 14 | 4.3 | 25 | 7.6 |
| | Okitipura | 108 | 3 | 2.8 | 24 | 22.2 |
| **Sub-total** | | **1550** | **88** | **5.7** | **69** | **4.5** |
| **Total** | | **2628** | **262** | **10.0** | **191** | **7.3** |

*: Community means a town or a village.

Akure, the state capital, has now grown to be a primate city which continues to attract people from the other rural areas and smaller towns in the state. This primacy has led to some problems. The traditional area of Akure, now the attraction of low income earners and the unemployed has deteriorated into slums.

### 2.2.3 Imo

The inhabitants of Imo State are Ibos (or lgbos), a culturally homogeneous group. The lbo language is spoken throughout the state with minor differences in dialects. The official language of the state is however, English. Imo State has a very rich cultural heritage. The primary enrolment rate is the 5$^{th}$ and the literacy rate is the 3rd in Nigeria. Non- poor rate is the 4$^{th}$ and Imo is a rich state. However, it has a high population density (3$^{rd}$ in Nigeria). This high population density has led to intensified pressure on land, forests and other natural resources, leading to increasing rural poverty, which is characteristic of densely populated rural areas. There are people who immigrate to other states for their jobs or farm land. Imo State has a number of mineral-based raw materials for industries, blessed with abundant mineral resources such as petroleum, natural gas, lead/zinc and limestone.

### 2.2.4 FCT

There several ethnic groups in the FCT, but the indigenous ethnic groups include but not limited to: Gbagyi, Gwari, Koro, Bassa, etc. Since the FCT is home to every Nigerian other ethnic nationalities such as Huasa, Fulani, Ibo and Yoruba also habit here. The primary enrollment rate, literacy rate and poverty rate are in the middle in Nigeria. Abuja was born in 1976 and it officially became Nigeria's capital in December 1991.

## 2.3 Socio-economic Rural Survey

### 2.3.1 Outline of the survey

The socio-economic rural survey, for which main field survey is done by a local consultant, can be divided into two (2) parts, Survey-1 and Surve-2, and all the survey results of the socio-economic rural survey have been reflected to the Mater Plan. The flow and the position of the socio-economic rural survey is shown in Fig. 2-1.

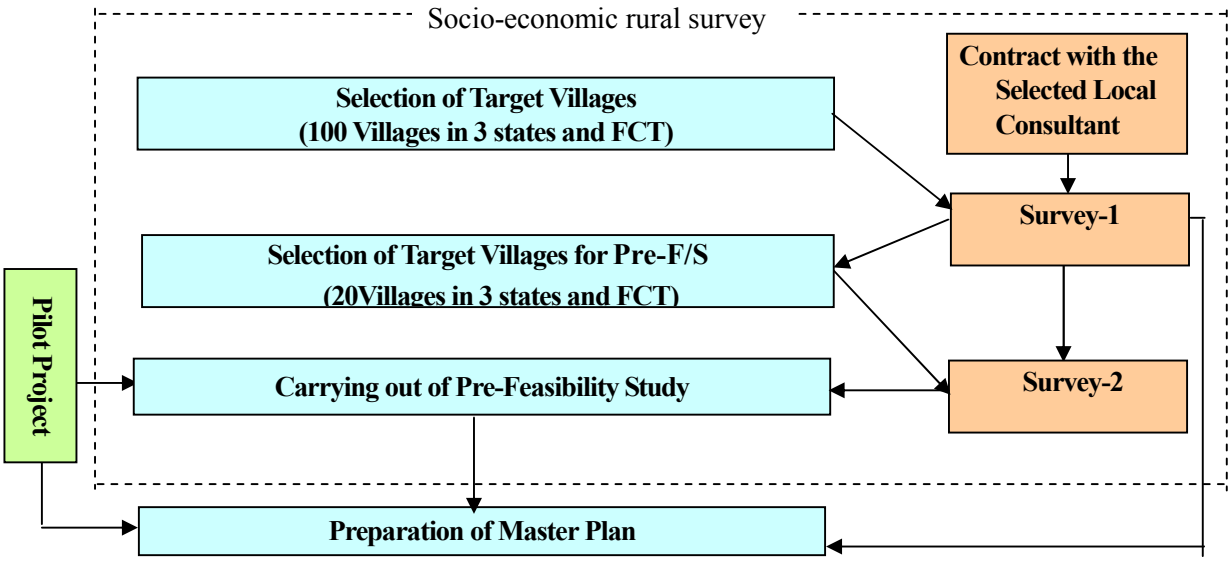



**Fig. 2-1 Flow and Position of Socio-Economic Rural Survey**

The method and contents for the respective field surveys are described below.

**Survey-1**

**Objective:** To obtain basic socio-economic data so as to understand general characteristics in the target areas and so as to select target villages for Pre-F/S of PV (Photovoltaic) electrification system.
**Target villages :** 100 villages in the 3 states (Jigawa, Ondo & Imo) and FCT

**a. Village level survey**
**Survey method:** interview based on the questionnaire to one (1) key- informant (village leader of the village)
**Survey items:**
Basic information (population, number of households, general map), industry and income source, social infrastructure (road, medical care, education, potable water), education, ethnic group, religion, existing organization (administration system, farmers' union, micro credit system), activities of the organizations (members, financial conditions), role of each gender, pubic facilities (water supply, clinic, school, meeting place, religious place), electric related facilities (generator, pump, street lights),
〔**for unelectrified villages**〕 Opinion on the proposed PV system
〔**for electrified villages**〕 O&M system (if any), used electrical appliances in public facilities and households, sense of satisfaction

**b. Household level survey**
**Survey method:** interview based on the questionnaire to five (5) household heads
**Survey items:** information of each family member, size of farm land, cultivated crops, owned livestock, income structure, itemized expenditure, use of electric appliances and electric sources (light, radio, TV, milling machine, etc.) energy use (kinds of energy, time and money to get them), desire for electricity, opinion on the proposed PV system, capacity/willingness to pay

**Survey-2**

**Objective:** To obtain their concrete opinion and request regarding PV electrification for the preparation of Pre-F/S

**Target villages:** 20 villages in the 3 states (Jigawa, Ondo & Imo)and FCT selected as Pre-F/S target

**Survey method:** Holding a workshop, Interview to the key informant

**Main survey items:**

- Desire on electrification of households (type of PV system, reason why PV system is desired, present condition of energy use)
- Desire on electrification on public facilities (Operating body, location, size of the building, income and expenditure, present condition of electrification, persons who pay electricity bill, willingness to pay)
- Introduction of an electric pump 〔if required〕 (Operating body, location, water quantity to be pumped, depth of the existing well, amount of fuel presently consumed, type of pump to be introduced)
- Business model (preferred type and reason for sales model/service model)
- Tariff system and money collecting system
- Micro credit system (availability for PV system, conditions for credit)
- Set-up of villagers organization
- Others (way to obtain spare parts of PV, code of conducts)
- Capacity development of the villagers to be required
- Villager's opinion/demand/concern on those items

### 2.3.2 Result of the Survey-1

#### (1) Target villages

The following table shows the number of the target villages for which the Survey-1 was done.

**Table 2-13 Number of Target Villages for Survey-1**

| | Jigawa | Ondo | Imo | FCT |
|---|---|---|---|---|
| Category A | 4 | 5 | 9 | 1 |
| Category B | 0 | 3 | 0 | 0 |
| Category C | 26 | 22 | 21 | 9 |
| **Total** | **30** | **30** | **30** | **10** |

Category A: Grid electrified
Category B: Diesel electrified
Category C: Unelectrified

#### (2) Ethnicity and religion

The composition of ethnicity and religion in those villages are described below.

In Jigawa State the main ethnicities are Housa and Fulani, and the villages can be categorized based on the Housa composition. Housa occupies more than 60% in 70 % of the villages, where Fulani occupy the second largest share. Housa has less than 20% share in eight (8) villages, where Kanuri is the major ethnicity (Fig. 2.2). Islam is the only religion in the Jigawa villages.

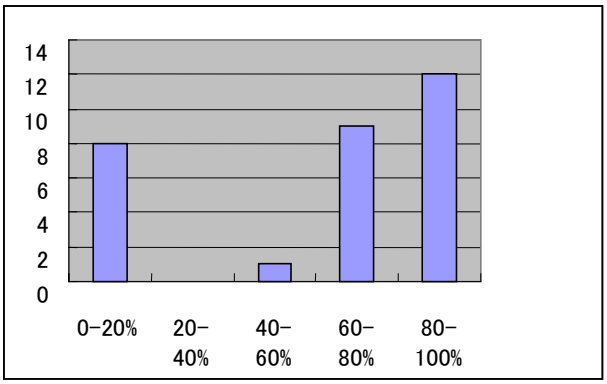



**Fig. 2-2 Village categorization based on Share of Hausa (Jigawa)**

In Ondo State the main ethnicity is Yoruba, and the villages can be categorized based on the Yoruba composition. Yoruba occupies more than 60% in 77 % of the villages. There are no Yoruba people in two (2) villages (Fig. 2-3). Christianity is the major religion in Ondo villages, occupying 60-100% of the villages in almost all the villages. Islam is the second major religion in many villages.

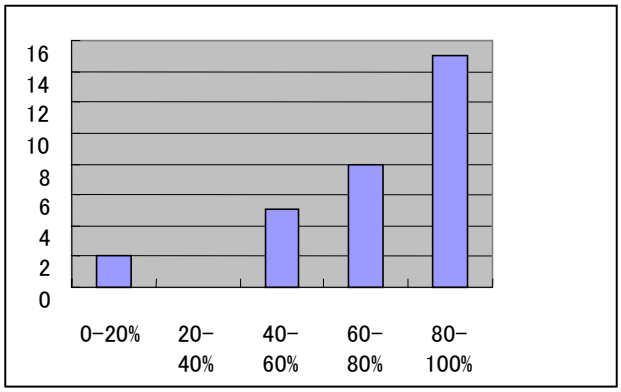



**Fig. 2-3 Village categorization based on Share of Yoruba (Ondo)**

In Imo State, main ethnicity is Ibo (or Igbo), and it occupies 95-100% in almost all the villages. Christians are 95-100% in almost all the villages, and they are followed by traditional religions. Muslims are few in Imo State.

In FCT, the situations are different in every village. There are four (4) villages where Gwari is the major ethnicity, but different ethnicities are major ethnicities in the rest six (6) villages. As for religion, Christianity is the main religion in six (6) villages, and Islam is the one in four (4) villages.

**(3) Family composition and occupation**

Numbers of wives and children in the households are shown in Table 2-14. In Jigawa, 65-75% of the villagers have more than two wives and more than 8 children. Both in Ondo and Imo, more than 94% have only one (1) wife and two (2) or three (3) children. In FCT, the situation is similar to that in Jigawa, 50-60 % of men have two or more wives and more than 8 children.

**Table 2-14 Number of wives and children in the households**

| | Category | Number of respondents | Number of wives | | | Average number of children |
|---|---|---|---|---|---|---|
| | | | One | Two | Three or more | |
| Jigawa | Category A | 20<br>100.0% | 5<br>25.0% | 12<br>60.0% | 3<br>15.0% | 10.1 |
| | Category C | 130<br>100.0% | 45<br>34.6% | 59<br>45.4% | 26<br>20.0% | 8.2 |
| Ondo | Category A | 25<br>100.0% | 25<br>100.0% | 0<br>0.0% | 0<br>0.0% | 2.2 |
| | Category B | 15<br>100.0% | 15<br>100.0% | 0<br>0.0% | 0<br>0.0% | 3.1 |
| | Category C | 110<br>100.0% | 104<br>94.5% | 3<br>2.7% | 3<br>2.7% | 2.2 |
| Imo | Category A | 45<br>100.0% | 43<br>95.6% | 2<br>4.4% | 0<br>0.0% | 3.3 |
| | Category C | 105<br>100.0% | 102<br>97.1% | 3<br>2.9% | 0<br>0.0% | 3.3 |
| FCT | Category A | 5<br>100.0% | 2<br>40.0% | 3<br>60.0% | 0<br>0.0% | 10.8 |
| | Category C | 45<br>100.0% | 22<br>48.9% | 16<br>35.6% | 7<br>15.6% | 8.8 |

Source: JICA Study Team (Socio-economic rural survey)

The occupations of the husbands are shown in Table 2-15. In Jigawa and FCT, farmers are the most followed by civil servants. In Ondo, farmers are the most in Category-A and Category-C villages. In Category-B villages in Ondo, civil servants and trader have around 30% share respectively and there are no farmers, because they are located at the riverine areas. In Imo, farmers are the most with the share of only 40-50%, and others' occupations show a wide variety.

**Table 2-15 Occupation of the husbands in the target villages**

| | Category | Number of respondents | Farmer | Civil servant | Trader | Fisher man | Pensioner | Other * |
|---|---|---|---|---|---|---|---|---|
| Jigawa | Category A | 20 | 12 | 4 | 3 | 0 | 0 | 1 |
| | | 100.0% | 60.0% | 20.0% | 15.0% | 0.0% | 0.0% | 5.0% |
| | Category C | 130 | 100 | 20 | 5 | 0 | 0 | 5 |
| | | 100.0% | 76.9% | 15.4% | 3.8% | 0.0% | 0.0% | 3.8% |
| Ondo | Category A | 25 | 13 | 0 | 3 | 8 | 0 | 1 |
| | | 100.0% | 52.0% | 0.0% | 12.0% | 32.0% | 0.0% | 4.0% |
| | Category B | 15 | 0 | 4 | 5 | 2 | 2 | 2 |
| | | 100.0% | 0.0% | 26.7% | 33.3% | 13.3% | 13.3% | 13.3% |
| | Category C | 110 | 86 | 0 | 9 | 9 | 0 | 6 |
| | | 100.0% | 78.2% | 0.0% | 8.2% | 8.2% | 0.0% | 5.5% |
| Imo | Category A | 45 | 18 | 2 | 15 | 0 | 0 | 10 |
| | | 100.0% | 40.0% | 4.4% | 33.3% | 0.0% | 0.0% | 22.2% |
| | Category C | 105 | 49 | 13 | 8 | 0 | 12 | 23 |
| | | 100.0% | 46.7% | 12.4% | 7.6% | 0.0% | 11.4% | 21.9% |
| FCT | Category A | 5 | 4 | 1 | 0 | 0 | 0 | 0 |
| | | 100.0% | 80.0% | 20.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| | Category C | 45 | 39 | 5 | 1 | 0 | 0 | 0 |
| | | 100.0% | 86.7% | 11.1% | 2.2% | 0.0% | 0.0% | 0.0% |

* As 'Other' the following occupations are included:
Jigawa: carpenter, guard, motor-cycle driver
Ondo: motor-cycle driver, teacher, tailor
Imo: motor-cycle driver, teacher, doctor, pharmacist, lawyer, technician, machine-operator, accountant
Source: JICA Study Team (Socio-economic rural survey)

The occupations of the wives of are shown in Table 2-16. In Jigawa and FCT, housewives occupy the most followed by traders. In Ondo and Imo, farmers and traders are the major occupations.

**Table 2-16 Occupation of the wives in the target villages**

| | Category | Number of corresponding persons | Housewife | Farmer | Trader | Teacher | Other/ unknown |
|---|---|---|---|---|---|---|---|
| Jigawa | Category A | 38 | 31 | 0 | 1 | 0 | 6 |
| | | 100.0% | 81.6% | 0.0% | 2.6% | 0.0% | 15.8% |
| | Category C | 248 | 228 | 0 | 17 | 0 | 3 |
| | | 100.0% | 91.9% | 0.0% | 6.9% | 0.0% | 1.2% |
| Ondo | Category A | 25 | 0 | 11 | 11 | 0 | 3 |
| | | 100.0% | 0.0% | 44.0% | 44.0% | 0.0% | 12.0% |
| | Category B | 15 | 3 | 0 | 11 | 0 | 1 |
| | | 100.0% | 20.0% | 0.0% | 73.3% | 0.0% | 6.7% |
| | Category C | 119 | 13 | 37 | 58 | 1 | 10 |
| | | 100.0% | 10.9% | 31.1% | 48.7% | 0.8% | 8.4% |
| Imo | Category A | 47 | 5 | 12 | 17 | 7 | 6 |
| | | 100.0% | 10.6% | 25.5% | 36.2% | 14.9% | 12.8% |
| | Category C | 108 | 4 | 60 | 26 | 4 | 14 |
| | | 100.0% | 3.7% | 55.6% | 24.1% | 3.7% | 13.0% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FCT | Category A | 8<br>100.0% | 4<br>50.0% | 0<br>0.0% | 1<br>12.5% | 0<br>0.0% | 3<br>37.5% |
| | Category C | 76<br>100.0% | 44<br>57.9% | 0<br>0.0% | 11<br>14.5% | 0<br>0.0% | 21<br>27.6% |

Source: JICA Study Team (Socio-economic rural survey)

**(4) Results of Grid Electrified Village (Category A) Survey**

A survey for grid-electrified villages was done in nineteen (19) villages and the conditions can be summarized as below.

1) Electricity meters are not installed and the tariff is decided by the PHCN officials arbitrarily. The common monthly rate per household is 500 ₦ in Jigawa, 950-1,450 ₦ in Ondo, 1,500-2,000 ₦ in Imo and 550 ₦ in FCT. The respondents complain that they can not consume electricity worth the tariff they pay because of frequent power failure.
2) Power failure is very common, and the period of power failure lasts 30%-90% of the entire time. And it is closely related with the users' satisfaction. In Zareku village, Jigawa, where power failure is 30 % of a entire day, all the respondents are satisfied with the current conditions, and in Jajeri village, Jigawa with 35% of power failure, 60% of the respondents are satisfied. However, in all the villages other than those two (2) villages are not satisfied.
3) All the respondents point that 'Frequent power failure' is the problem. And 'High electricity rate' and 'High price of electric appliances' are also raised by many people as problems.
4) The income/expense comparison between present condition and the condition before electrification, almost all the respondents in Imo and FCT say they have more income than electrification by 5-25%, and more expense by 5-25% at the same time. In Zareku village in Jigawa all the respondents say the expense has been increased by 30-50%, while income remains unchanged.
5) The owned electricity appliances are radio (85), light (55) , fan (24), TV (21), iron(20), heater(4), refrigerator(1) with numbers who own them, out of 90 respondents.
6) As for electrified public facilities, clinics and mosques/churches are electrified in many villages, and it is considered that they are electrified because those are important and used by many residents. Streets lights are installed in Jigawa and Ondo, but the priority is not put to street lights in Imo and FCT. In Imo eight (8) villages out of nine (9) villages have electrified their town halls.

**(5) Results of Diesel Electrified Village (Category B) Survey**

A survey for diesel-electrified villages was done in three (3) villages in Ondo. The diesel electrified villages are all located in the riverine area, and their main occupation is fishing followed by faming, boat driving and wine tapping. All the generators in those villages were donated by the government through Niger Delta Development Commission (NDDC). Table 2-17 shows the operation conditions of the generators.

**Table 2-17 Operation Conditions of the Generators**

| Village | Ugbonla | Arogbo | Mahin |
|---|---|---|---|
| Capacity of generator | 300 kV | 300 kV | 300 kV |
| Unit price of diesel | ₦ 200 | ₦ 76 | ₦ 80 |
| Consumed diesel per month | worth ₦ 25,000 | worth ₦ 22,800 | worth ₦ 18,000 |
| Operation cost | NA | ₦ 2,000/month | ₦ 4,000/month |
| No. of staff for operation | 12 | 2 | 4 |
| No. of covered households | 1,000 | 3,000 | 3,000 |

Source: JICA Study Team (Socio-economic rural survey)

The following problems are raised, and the residents cannot rely on those generators much, therefore, many people have their own small generators for themselves.

1) The village has two (2) generators, only one of which is functional. The other generator has been out of order for some time and the village cannot afford the repairs. One of the big problems is high cost of maintenance and purchase of diesel, and the generator works during 8-12 pm to save cost (Ugubonla).
2) The generator is seldom used because of high cost of fuel. There are many personal generators (Arogbo & Mahin).

**(6) Results of Unlectrified Village (Category-C) Survey**

A survey for unelectrified villages was conducted in seventy eight (78) villages in 3 states and FCT.

1) Income source

Main income source is agriculture in all the villages. And the second income sources are animal husbandry (in Jigawa), both animal husbandry and commerce (in Ondo) and commerce (in Imo). Other income sources are handicraft, migrant work, public service, motorcycle driving, etc. in all the villages. The average income is shown in Table 2.18.

2) Expenditure

The average monthly income/expenditure is shown in Table 2-18. Expenditure for food, energy and transportation are large amount of expenditure in Jigawa, and food, education and energy in Ondo and Imo. Saving occupies the largest amount in FCT, followed by food and energy. The total expenditure is only 75% of the total income, and the use of the remaining 25% is unknown in Jigawa and Ondo. It is considered because it was difficult for the residents to grasp all the expenditure as expense is not done regularly.

**Table 2-18 Average Monthly Income/Expenditure**

| | Jigawa | | Ondo | | Imo | | FCT | |
|---|---|---|---|---|---|---|---|---|
| | Amount 〔N/month〕 | 〔%〕 | Amount 〔N/month〕 | 〔%〕 | Amount 〔N/month〕 | 〔%〕 | Amount 〔N/month〕 | 〔%〕 |
| **Total Income** | **14,077** | **100.0** | **21,810** | **100.0** | **28,648** | **100.0** | **44,012** | **100.0** |
| **Total Expense** | **10,555** | **75.0** | **16,079** | **73.7** | **28,510** | **99.5** | **43,938** | **99.8** |
| House rent | 0 | 0.0 | 100 | 0.5 | 821 | 2.9 | 18 | 0.0 |
| Food | 5,412 | 38.4 | 5,476 | 25.1 | 5,697 | 19.9 | 9,619 | 21.9 |
| Medical care | 613 | 4.4 | 1,738 | 8.0 | 4,566 | 15.9 | 3,406 | 7.7 |
| Education | 362 | 2.6 | 3,629 | 16.6 | 5,485 | 19.1 | 4,261 | 9.7 |
| Transportation | 1,423 | 10.1 | 1,676 | 7.7 | 3,362 | 11.7 | 4,285 | 9.7 |
| Saving | 0 | 0.0 | 338 | 1.6 | 1,369 | 4.8 | 11,430 | 26.0 |
| Energy/fuel | 1,716 | 12.2 | 2,658 | 12.2 | 5,344 | 18.7 | 6,783 | 15.4 |
| Others | 1,029 | 7.3 | 464 | 2.1 | 1,867 | 6.5 | 4,137 | 9.4 |

Source: JICA Study Team (Socio-economic rural survey)

3) Energy Source and Expenditure

Main energy sources for all the villages can be summarized as shown below.

**Table 2-19 Energy Sources**

| Purpose | Energy Source | Remarks |
|---|---|---|
| Cooking | Firewood | Commonly used, sometimes collected by themselves (free of charge) sometimes purchased |
| | Kerosene | Not used often because of high cost |
| Lighting | Kerosene | Commonly used |
| | Palm oil | Used often in Imo because they produce it and no need to pay for it |
| | Diesel | Numbers of generator owners/respondents are: 9/130(Jigawa,), 3/110(Ondo), 12/105(Imo) and 9/45(FCT) |
| | Dry cell | Used for flashlight, which is used both inside and outside. |
| Radio | Dry cell | Radios are owned by most people |
| Others | Diesel | Used for a fan, TV, etc. by some people |

Source: JICA Study Team (Socio-economic rural survey)

Based on Table 2−19, it is considered those that can be replaced by PV system are the use of kerosene, diesel and dry cells for radios. Flashlights are excluded because the use of them is found not to be always replaced by the use of PV system. Table 2−20 shows the average expenditure of those energy sources. The income is also included in the Table 2−20 to show the percentage of the energy expense to the income. Imo has the largest percentage of the said energy expense (13.3%), and the percentages are in the range of 6.5-7.7% in other states and FCT.

**Table2-20 Energy Expense that can be replaced by PV system**

〔Unit: N/month〕

| | Jigawa | Ondo | Imo | FCT |
|---|---|---|---|---|
| ① Average monthly expense for kerosene & diesel | 762 | 1,451 | 3,657 | 2,873 |
| ② Average monthly expense for dry cells for radios | 155 | 223 | 148 | 280 |
| ③ Total expense that can be replaced by PV system ①+② | 917 | 1,674 | 3,805 | 3,153 |
| ④ Average monthly income | 14,077 | 21,810 | 28,648 | 44,012 |
| ⑤ Percentage of above energy expense ③/④*100 | 6.5% | 7.7% | 13.3% | 7.2% |

Source: JICA Study Team (Socio-economic rural survey)

4) Estimated Capacity to Pay and available PV system

Capacity to pay to PV system was estimated based on the present energy expenditure. The energy sources that can be replaced by PV system are kerosene, diesel and dry cells for radios as mentioned above, but those include energy consumption that will be necessary (ex. kerosene for the lamp used all over the night) even if PV system is introduced. And it is assumed to be about 10% of the above-mentioned energy expenditure, therefore, the estimation was done based on the conditions that the residents will pay 90% of the present total expenditure for the kerosene, diesel and dry cells for radios. The tariff for each PV system is calculated as below based on the conditions shown in Chapter 3 Financial and Economic Analysis.

**Table 2-21 Tariff for each PV system**

| | PV system | Tariff (N/month) |
|---|---|---|
| 1 | BCS | 800 |
| 2 | SHS55W | 1200 |
| 3 | SHS110W | 1600 |
| 4 | Mini grid | 2000 |
| 5 | SHS165W | 2700 |

Remark: Tariff for BCS includes basic rate (620N) + charging rate (180N)

Source: JICA Study Team

All the survey target households were categorized into six (6) groups according to the estimated capacity to pay based on the tariff in Table 2−21. For example, a household whose estimated capacity to pay is 1,500N/month is categorized as a group that can have a SHS55W system. The categorization is illustrated in Fig.2−4. Eight (8) % of households can have BCS, and 15% for SHS55W system in Jigawa, though 70% of households cannot afford to any PV system. Fifty four (54) % of households can have SHS110W in Ondo. Mini-grid and SHS165W are available for 31% and 25% of households respectively in Imo. The capacity to pay is various in FCT, though 22% of the households cannot afford to any system. An initial payment, for example, 28,800N for SHS55W, is necessary other than the monthly tariff, but it is not taken into consideration in this calculation.

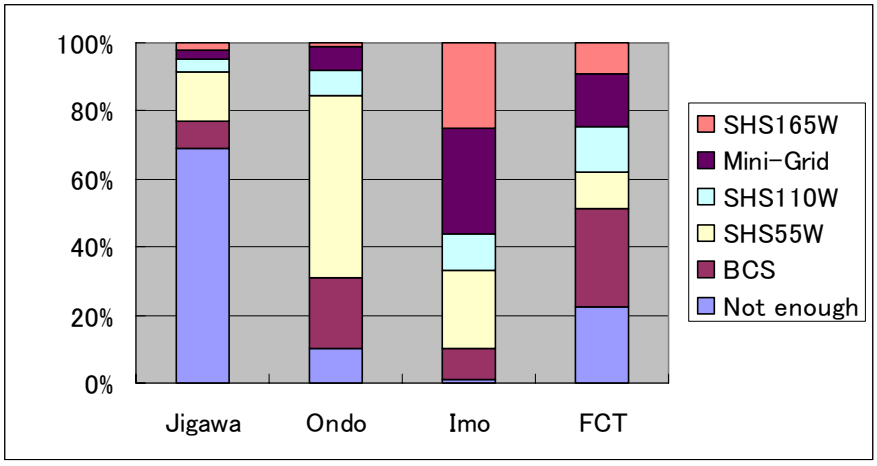



**Fig.2-4 PV system distribution that can be introduced based on the Estimated Capacity to Pay**

5) Willingness to pay based on questionnaire results on BCS/SHS

A survey on willingness to pay for BCS and SHS55W was conducted in the Survey-1(Table 2.21). The willingness to pay for SHS is higher than that for BCS, and more than 70% of people prefer SHS system. The reason why they do not like BCS is that battery charge, which has to be done once in several days, is troublesome.

**Table 2-22 Willingness to Pay for PV System**

| | **Jigawa** | **Ondo** [2)] | **Imo** | **FCT** |
|---|---|---|---|---|
| No. of respondents | 130 | 110 | 105 | 45 |
| BCS | | | | |
| ₦400-500 | 0.8% | — | 1.9% | 0% |
| ₦300-400 | 73.8% | — | 1.9% | 0% |
| ₦200-300 | 21.5% | — | 24.8% | 71.1% |
| ₦100-200 | 3.8% | — | 54.3% | 28.9% |
| ₦ 0-100 | 0% | — | 17.1% | 0% |
| **Average**[1)] | **₦ 321.5** | **—** | **₦ 167.1** | **₦ 221.1** |
| SHS55W | | | | |
| ₦600— | 0% | 9.5% | 0% | 0% |
| ₦500-600 | 60.8% | 9.5% | 0% | 2.2% |
| ₦400-500 | 20.8% | 13.3% | 1.9% | 97.8% |
| ₦300-400 | 12.3% | 26.7% | 6.7% | 0% |
| ₦200-300 | 6.2% | 41.0% | 50.0% | 0% |
| ₦100-200 | 0% | 0% | 34.6% | 0% |
| ₦ 0-100 | 0% | 0% | 6.7% | 0% |
| **Average** | **₦ 486.2** | **₦ 365.2** | **₦ 212.5** | **₦ 452.2** |
| Preferred PVsystem | | | | |
| BCS | 8.5% | 0.0% | 0.0% | 2.2% |
| SHS | 76.2% | 74.3% | 100.0% | 97.8% |
| Either | 15.4% | 25.7% | 0.0% | 0.0% |

1) Average was calculated using the intermediate value (e.g.₦350 for '₦300-400')
2) A separate survey for BCS and SHS was not done, and therefore, the survey results is the answer responding to the question 'How much are you willing to pay for BCS or SHS' in Ondo.
Source: JICA Study Team (Socio-economic rural survey)

### 2.3.3 Selection of Pre-F/S villages

The villages that meet the following requirements have been selected as target villages for Pre-F/S based on the Survey-1 results. The conditions were eased considering the fact, e.g. many villages have smaller population than 1,000 in Ondo, and the distance to the existing grid is less than 12 km in many villages in Imo. The conditions of 3), 4) and 5) are satisfied by all those villages. The selected villages are shown in Table 2-23.

1) To have population more than 1,000,
2) To be located further than 20km from the existing grid,
3) Not to have electrification plan by 2020,
4) To have active villagers' organization and
5) To be positive toward introduction of PV system

Survey-2 was conducted in those villages, and is positioned as a preparatory survey for the Pre-F/S. The results are described in Chapter 5.

**Table 2-23 Target Villages for Pre-F/S**

| No. | Local Government | Village | Population | Distance from the existing grid (km) |
|---|---|---|---|---|
| Jigawa | | | | |
| 1 | Babura | Giginya | 6,700 | 18 |
| 2 | Sule Tankarkar | Maitsamiya | 4,000 | 10.5 |
| 3 | Kirikasamma | Jarmari | 5,500 | >8 |
| 4 | Ringim | Auramo Tudu | 4,600 | 12 |
| 5 | Jahun | Kale Hayintara | 3,650 | 9～10 |
| 6 | Buji | Dankoshe | 1,970 | 12 |
| Ondo | | | | |
| 1 | Ondo East | Tekule | 1,200 | 12 |
| 2 | Ese Odo | Shegbemi | 2,300 | 50 |
| 3 | Ondo West | Oloruntedo | 1,200 | 15 |
| 4 | Idanre | Fayomi Camp | 500 | 20 |
| 5 | Ondo West | Kajola Camp | 500 | 4 |
| 6 | Idanre | Onisere | 1,500 | 10 |
| Imo (A name in parentheses after a village name is the community name the villages belongs to) | | | | |
| 1 | Aboh-Mbaise | Agunumee (Nri-Ukwu) | 4,000 | 15 |
| 2 | Aboh-Mbaise | Obokuw (Mbutu) | 8,000 | 7 |
| 3 | Owerri West | Umuokpo(Emeabiam) | 3,300 | 6 |
| 4 | Ihitte Uboma | Umudim(Onicha-Uboma) | 6,500 | 7 |
| 5 | Orsu | Obibi(Okwuamasihe) | 4,000 | 7.5 |
| 6 | Orlu | Ozara(Mgbee) | 3,000 | 6 |
| FCT | | | | |
| 1 | Kuje | Gudun Karya | 1,000 | 23 |
| 2 | Abaji | Yelwan Gawu | 1,100 | 25 |

Source: JICA Study Team (Socio-economic rural survey)

## 2.4 Conditions of the Consumer Side

Eighty five percent (85%) of all general households utilize firewood for cooking in Nigeria. Fetching of firewood is one of the major causes of deforestation, and is very laborious work for women and girls. Kerosene accounts for approximately 10% of total energy consumption for lighting and cooking; and electricity use is less than 1%[1]. In grid electrified areas in Nigeria, electricity demand is very high. General households even in rural areas use color TVs, refrigerators, electric fans and irons, in addition to lighting demand. Table 2-24 shows the average power demand for home appliances utilized in Nigeria.

**Table 2-24 Average Power Demand for Home Appliances Utilized in Nigeria**

| Appliances | Type | Rating | Power Demand (kW) | Rated Current (A) | No. of hrs. to consume 1 kWh (h) |
|---|---|---|---|---|---|
| | | | | | |
| Lamp | Lamp | 40 W | 0.040 | 0.20 | 25.0 |
| ditto | | 60 W | 0.060 | 0.25 | 17.0 |
| ditto | | 100 W | 0.100 | 0.40 | 10.0 |
| Iron | Small | 750 W | 0.750 | 3.20 | 1.3 |
| ditto | Medium | 850 W | 0.850 | 3.60 | 1.2 |
| Toaster | Regular | 1,000 W | 1.000 | 4.30 | 1.0 |
| Kettle | Small | 2,000 W | 2.000 | 8.60 | 0.5 |
| ditto | Medium | 3,500 W | 3.500 | 15.00 | 0.3 |
| Water heater | 50 Litre | 1,200 W | 1.200 | 5.20 | 0.8 |
| ditto | 100 Litre | 2,500 W | 2.500 | 11.00 | 0.4 |
| Cooker | Small | 6,000 W | 6.000 | 26.00 | 0.2 |
| (4-plate with oven) | Regular | 8,000 W | 8.000 | 34.00 | 1.2 |
| ditto | Large | 10,500 W | 10.500 | 45.00 | 0.1 |
| Single plate cooker | Portable | 18,000 W | 1.800 | 7.70 | 0.6 |
| Fan | Table | 0.08 HP | 0.060 | 0.25 | 17.0 |
| ditto | Standing | 0.1 HP | 0.700 | 0.30 | 14.0 |
| ditto | Celling | 0.3 HP | 0.220 | 0.90 | 45.0 |
| Air conditioner | Small | 1.5 HP | 1.100 | 4.70 | 1.0 |
| ditto | Medtum | 2 HP | 1.500 | 6.50 | 0.7 |
| Refrigerator | Small | 0.2 HP | 0.150 | 0.60 | 7.0 |
| ditto | Medium | 0.25 HP | 0.190 | 0.80 | 5.0 |
| ditto | Large | 0.3 HP | 0.220 | 0.90 | 4.5 |
| Translstor Radio | | 5.0 W | 0.005 | 0.02 | 2.0 |
| Radio gram/ Stereo system | | 100 W | 0.100 | 0.40 | 10.0 |
| Television (Black & White) | | 200 W | 0.200 | 0.90 | 5.0 |
| Television (colour) | | 300 W | 0.300 | 1.30 | 3.0 |
| Vacuum cleaner | Small | 700 W | 0.700 | 3.00 | 1.4 |
| ditto | Medium | 900 W | 0.900 | 3.90 | 1.0 |
| Water pump | | 0.6 HP | - | 1.90 | 2.5 |
| Washing machine | Non Automatic | 300 W | 0.300 | 1.29 | 3.0 |
| ditto | Automatic | 600 W | 0.600 | 2.50 | 2.0 |
| ditto | Automatic with heater | 3,000 W | 3.000 | 13.00 | 0.3 |

1,000 Watt = 1 kilowatt (1 kW)
1 HP = 0.740 kilowatt
1 kwh = One Unit of Electricity = 1 kW X 1hr (i.e. kilowatt used for hour)

Source: FMPS

[1] "Rural Development Sector Strategy" by Federal Ministry of Agriculture and Rural Development, P37

As Table 2-25 shows, the average load per household in the existing grid electrified areas is 112W. However, the average load per household is 30-40W in rural areas, much smaller than the national average, and it is found that average load per household is very different among respective states. The load per household in Jigawa, Ondo and Imo States is 20-40W, and it is much smaller in off-grid areas. Therefore, the potential demand which can be supplied by SHS (55W) or BCS is quite substantial.

**Table 2-25 Average Power Demand per Household (Grid Electrified Areas)**

| No. | State | Load allocation recorded in 2003 (MW) (1) | Population by 1991 Census | Estimated Population in 2004 (2) | Load per population (W/people) (1)/(2) | Number of Households (3) | Load per Household (W/house) (1)/(3) |
|---|---|---|---|---|---|---|---|
| 1 | Abia | 44.20 | 1,913,917 | 3,006,618 | 14.70 | 601,324 | 74 |
| 2 | Adamawa | 53.30 | 2,102,053 | 3,302,165 | 16.14 | 660,433 | 81 |
| 3 | Akwa-Ibom | 58.60 | 2,409,314 | 3,784,849 | 15.48 | 756,970 | 77 |
| 4 | Anambra | 88.28 | 2,796,475 | 4,393,049 | 20.10 | 878,610 | 100 |
| 5 | Bauchi | 31.20 | 2,861,887 | 4,495,807 | 6.94 | 899,161 | 35 |
| 6 | Bayelsa | 0.00 | 1,121,693 | 1,762,094 | 0.00 | 352,419 | 0 |
| 7 | Benue | 23.90 | 2,753,077 | 4,324,874 | 5.53 | 864,975 | 28 |
| 8 | Borno | 42.40 | 2,536,003 | 3,983,868 | 10.64 | 796,774 | 53 |
| 9 | Cross River | 22.10 | 1,911,596 | 3,002,972 | 7.36 | 600,594 | 37 |
| 10 | Delta | 75.02 | 2,590,491 | 4,069,464 | 18.43 | 813,893 | 92 |
| 11 | Ebonyi | 27.50 | 1,453,882 | 2,283,938 | 12.04 | 456,788 | 60 |
| 12 | Edo | 124.30 | 2,172,005 | 3,412,054 | 36.43 | 682,411 | 182 |
| 13 | Ekiti | 15.85 | 1,535,790 | 2,412,609 | 6.57 | 482,522 | 33 |
| 14 | Enugu | 100.20 | 2,125,068 | 3,338,320 | 30.02 | 667,664 | 150 |
| 15 | Gombe | 16.60 | 1,489,120 | 2,339,294 | 7.10 | 467,859 | 35 |
| 16 | Imo | 22.10 | 2,485,635 | 3,904,743 | 5.66 | 780,949 | 28 |
| 17 | Jigawa | 22.40 | 2,875,525 | 4,517,231 | 4.96 | 903,446 | 25 |
| 18 | Kaduna | 165.80 | 3,935,618 | 6,182,556 | 26.82 | 1,236,511 | 134 |
| 19 | Kano | 184.70 | 5,810,470 | 9,127,806 | 20.23 | 1,825,561 | 101 |
| 20 | Katsina | 43.80 | 3,753,133 | 5,895,886 | 7.43 | 1,179,177 | 37 |
| 21 | Kebbi | 20.20 | 2,068,490 | 3,249,440 | 6.22 | 649,888 | 31 |
| 22 | Kogi | 16.60 | 2,147,756 | 3,373,961 | 4.92 | 674,792 | 25 |
| 23 | Kwara | 58.50 | 1,548,412 | 2,432,437 | 24.05 | 486,487 | 120 |
| 24 | Lagos | 1006.20 | 5,725,116 | 8,993,721 | 111.88 | 1,798,744 | 559 |
| 25 | Nassarawa | 33.20 | 1,207,876 | 1,897,481 | 17.50 | 379,496 | 87 |
| 26 | Niger | 84.50 | 2,421,581 | 3,804,119 | (*)22.21 | 760,824 | 111 |
| 27 | Ogun | 81.70 | 2,333,726 | 3,666,106 | 22.29 | 733,221 | 111 |
| 28 | Ondo | 29.00 | 2,249,548 | 3,533,869 | 8.21 | 706,774 | 41 |
| 29 | Osun | 111.20 | 2,158,143 | 3,390,278 | 32.80 | 678,056 | 164 |
| 30 | Oyo | 132.70 | 3,452,720 | 5,423,960 | 24.47 | 1,084,792 | 122 |
| 31 | Plateau | 68.00 | 2,104,536 | 3,306,066 | 20.57 | 661,213 | 103 |
| 32 | Rivers | 88.50 | 3,187,864 | 5,007,892 | 17.67 | 1,001,578 | 88 |
| 33 | Sokoto | 37.80 | 2,397,000 | 3,765,504 | 10.04 | 753,101 | 50 |
| 34 | Taraba | 44.20 | 1,512,163 | 2,375,493 | 18.61 | 475,099 | 93 |
| 35 | Yobe | 22.10 | 1,399,687 | 2,198,802 | 10.05 | 439,760 | 50 |
| 36 | Zamfara | 22.10 | 2,073,176 | 3,256,802 | 6.79 | 651,360 | 34 |
| 37 | Abuja | 121.60 | 371,674 | 583,872 | 208.26 | 116,774 | 1041 |
| | Total | 3140.35 | 88,992,220 | 139,800,000 | 35.29 | 27,960,000 | 112 |

Remarks: *=Average rate in the country
Note: (2) Population in each State is extrapolated based on the 2004 World Bank estimated total population and 1991Population Census of Nigeria by the National Population Commission.
Note: (3) Average number of people living in one household (5) is applied.

## 2.5 Electricity Demand in Off-grid areas

The numbers of villages that are electrified and planned to be electrified are shown below. In Jigawa State, only the list of the towns/villages electrified during 1999-2005 was available, and so the exact number of the electrified towns/villages is not known. In Ondo State 191 towns/villages (7.3% of the total numbers) were electrified. In Imo Sate, the list of electrified towns/villages includes 152 names, and some of them are communities, which have plural villages inside. Therefore, more than 152 towns/villages are electrified in Imo States, but exact number is not known. In FCT, 222 towns/villages are estimated to be electrified. Only Imo States has a list of towns/villages that are planned to be electrified. The exact number is not known, but it is obvious there still are many towns/villages that need electrification.

**Table 2-26 Numbers of Villages Electrified and Planned to be Electrified**

| | Jigawa | Ondo | Imo | FCT |
|---|---|---|---|---|
| Number of Local Government Area (LGA) | 27 | 18 | 27 | 6 |
| Approximate number of towns/villages | 5,000 | 2,600 | 2,200 | 300 |
| Electrified towns/villages | 36[1)] | 191 | 152[2)] | 222 |
| Towns/villages planned to be electrified | NA | NA | 30[2)3)] | NA |

Source: JICA Study Team
[1)] Only electrified villages from 1999 to 2005 (Data other than this is not available)
[2)] The number includes the number of communities, which have plural villages inside respectively.
[3)] Those are planned to be electrified by 2010

Based on the interview on electric appliances the villagers want to use, many people raised lights, radios, televisions, refrigerators and fans as they want to use, and therefore, it is desirable to supply electricity that corresponds to the use of those electricity appliances at the first PV electrification stage. Their expected benefit by electrification is summarized in Table 2-27.

**Table 2-27 Expected Benefit Brought by Electrification**

| Place | Electric appliance | Expectation |
|---|---|---|
| **At home** | | |
| Home | Light | - to make housework easier<br>- to control insects<br>- to provide opportunities to conduct activities at night<br>- to enhance chances for getting information and entertainment<br>- to get rid of soot of lamps<br>- (in the area where palm oil is used for lamps) to prevent damage by lamps (Presently it has bad effects on eyes and the respiratory organ, and possibility to cause explosion because of impurities of palm oil.)<br>- to prevent injuries and accidents<br>- to prevent fire by kerosene lamps<br>- to help to prevent livestock theft<br>- to reduce fear of dark |
| | Fan | - to make feel cool, especially after work in the field<br>- to prevent malaria by keeping mosquitoes away |
| | Refrigerator | - to make save transportation fee to buy meat/fish because it can be kept refrigerated |
| | All | - to make save money for kerosene and batteries |
| | Oil extractor | - to make oil extraction of groundnuts more effectively |
| | Milling machine | - to make process of millet more effectively |
| **At public facilities** | | |
| School | Computer | - to provide opportunities for students to learn how to use computers |
| Adult school | Light | - to provide opportunities to learn effectively |
| Street light | | - to enhance security at night (People carry flashlights, lamps or firewood with fire on the top of it, when they go out at night, but those all are not bright enough. And as for flash lights the light bulbs often go dead, firewood may cause fire if handled carelessly). |
| Clinic | Light | - to provide better treatment by dealing with emergency at night |
| | Refrigerator | - to keep medicine refrigerated |
| Borehole | PV pump | - to make fetching water easier |
| **For business** | | |
| Process-ing | Oil extractor | - to make oil extraction of groundnuts more effectively |
| | Milling machine | - to make process of millet more effectively |
| Others | Refrigerator | - to enhance business opportunities (selling ice, cold drink, etc.) |
| | Electric sewing machine | - to make sewing easier |

# Chapter 3 General Situation of the Power Sector and Use of Solar Energy

## 3.1 Outline of Power Supply and Demand

### 3.1.1 Situation of Power Supply in Nigeria and Nationwide Balance of Power Supply and Demand

The electricity sector in Nigeria is under the supervision of the FMPS and the National Electric Power Authority (NEPA) has historically been in charge of the nationwide operation and maintenance of power generating, transmission and distribution facilities. There are areas, however, where the Rural Electricity Board (REB) of the state government plans and operates electricity-related facilities or where the National Electricity Supply Corporation (NESCO) and other independent power providers (IPPs) provide an electricity supply service. Nigeria has been promoting the Power Sector Reform Programme in accordance with the National Economic Empowerment and Development Strategy (NEEDS). In March, 2005, the Electric Power Sector Reform Bill was approved by President Obasanjo, formally effectuating the Electric Power Sector Act. As a result, the NEPA was divided into six generating companies, one transmission company and 11 distribution companies and the PHCN was established in May, 2005. Fig. 3-2 shows the Nigerian power grid, including power stations and substations.

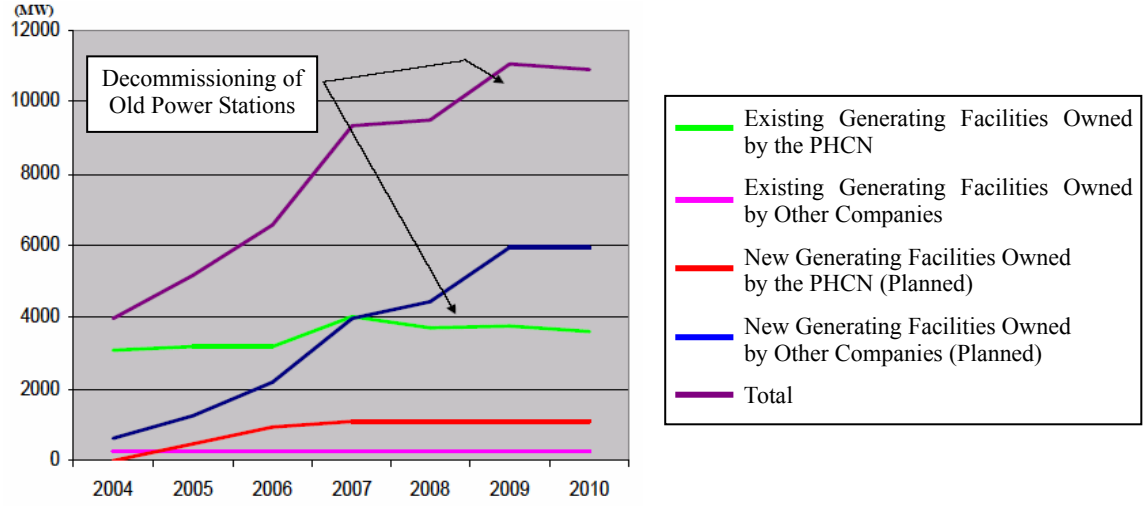
Table 3-1 shows the power generation and sales performance of the PHCN from 2001 to 2005. It can be seen that the installed generating capacity stayed at the same level until 2005 while the maximum power demand and net system energy demand recorded high average annual growth rates of 8% and 14% respectively, resulting in a shortfall of the electricity supply by the generating facilities owned by the PHCN alone in recent years. Apart from the PHCN, IPPs have their own generating facilities in Nigeria. Because these IPPs have a combined installed generating capacity of 750 MW as of 2006, the available output is just about enough to meet the maximum power demand. However, because of a fairly large potential demand, there is actually a substantial shortage of supply capacity. Since 2004, the total number of users of the PHCN has shown a declining trend, recording an 8% decline in 2005 compared to a peak in 2003. This decline indicates a growing trend of large and commercial users which are averse to the extremely unreliable power supply of the PHCN due to frequent power failures procuring their own independent power generators to achieve a self-sufficient power supply.

**Table 3-1 Power Generation and Sales Results of the PHCN**

| | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|
| Installed Generating Capacity (MW) | 6,158 | 6,085 | 6,119 | 6,119 | 6,104 |
| Available Output (MW) | 2,525 | 3,211 | 3,781 | 3,410 | 3,736 |
| Maximum Power Demand (MW) | 3,242 | 3,243 | 3,479 | 3,427 | 3,774 |
| Generated Energy (GWh) | 16,841 | 21,532 | 22,612 | 24,132 | 24,008 |
| Net System Energy Demand (GWh) | 9,649 | 19,098 | 20,499 | 21,632 | 16,458 |
| Total Number of Users (x 1,000) | 3,300 | 4,656 | 4,805 | 4,560 | 4,431 |

Source: PHCN

The net system energy demand in Nigeria is expected to grow at an average annual rate of 10 – 11% in the 15 year period from 2005 to 2020. [1)] For this reason, the Government of Nigeria aims at increasing the installed generating capacity to 10,000 MW, the transmission capacity to 9,340 MVA and the distribution capacity to 15,165 MVA by 2007 in its NEEDS. Fig. 3-1 and Table 3-2 show the planned expansion of the generating facilities in the coming years.




Source: PHCN, "The Power Sector: *The Catalyst for Economic Growth & Development*", March, 2004

**Fig. 3-1 Generating Facilities Expansion Plan**

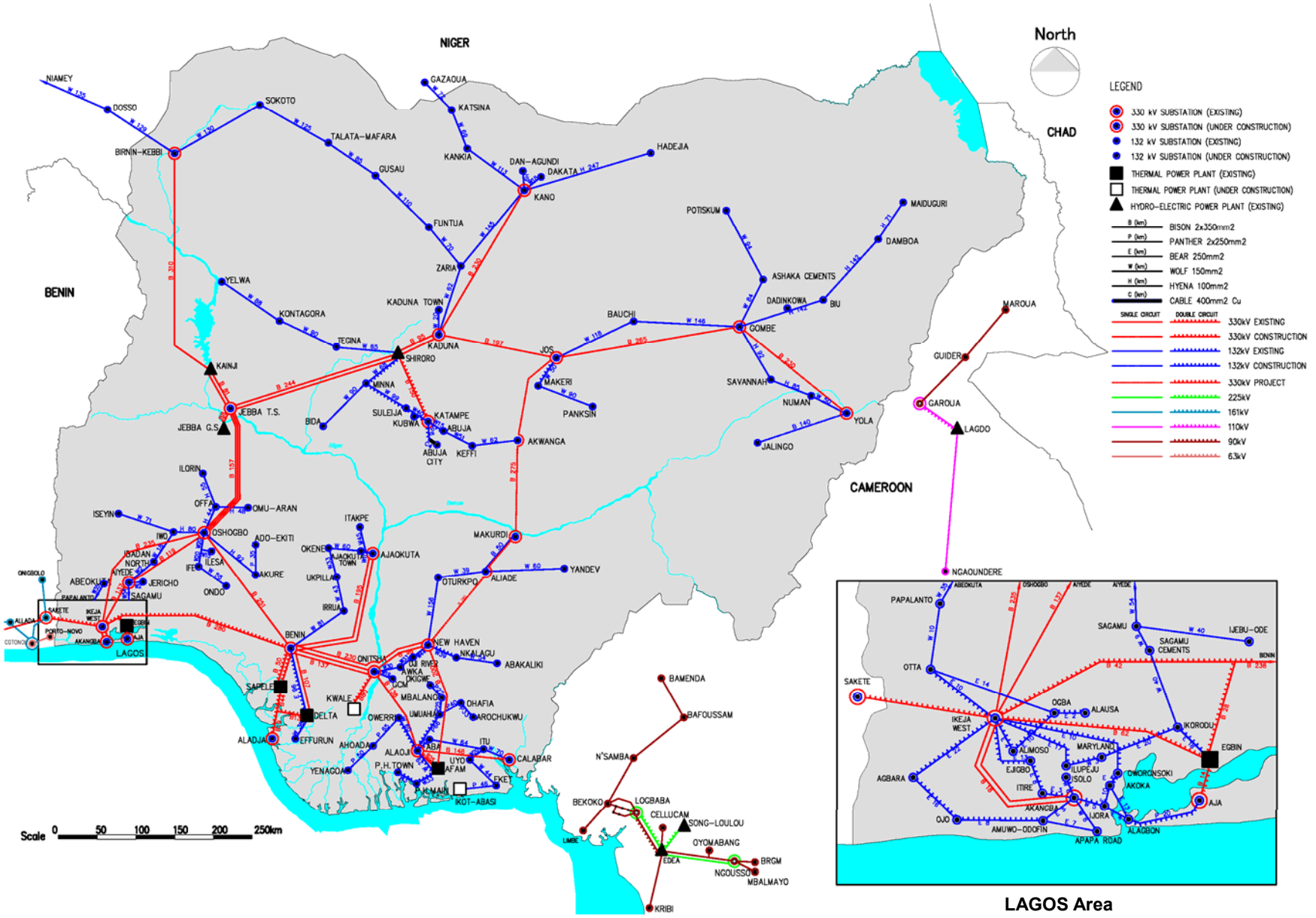
**Table 3-2 Generating Facilities Expansion Plan in Nigeria (Formulated in 2006)**

(Unit: MW)

| | Dec., 2006 | May, 2007 | Dec., 2007 | Dec., 2008 | Dec., 2009 | Dec., 2010 |
|---|---|---|---|---|---|---|
| Existing PHCN Power Stations (Available Output) | 3,357 | 4,027 | 4,027 | 3,880 | 3,780 | 3,780 |
| Existing IPP Power Stations (Available Output) | 750 | 750 | 750 | 750 | 750 | 750 |
| Government Projects (In Progress) | 1,001 | 1,462 | 1,496 | 2,511 | 3,528 | 4,544 |
| Niger Delta Programme | 0 | 1,315 | 2,203 | 2,624 | 2,624 | 2,624 |
| IPP Expansion Programme (JV) | 0 | 876 | 1,820 | 2,790 | 2,790 | 2,790 |
| Other IPPs | 90 | 510 | 510 | 1,265 | 1,365 | 1,365 |
| Total | 5,198 | 8,940 | 10,806 | 13,820 | 14,837 | 15,853 |

Source: PHCN

1) Forecast on the base case of the power demand compiled by the PHCN




Source: PHCN

**Fig. 3-2 National Power Grid Diagramme**

### 3.1.2 Present Situation of the Existing Power Facilities

#### (1) Generating Facilities

In Nigeria, electricity is supplied nationwide by thermoelectric power plants operated by the PHCN and IPPs in the southern coastal region and by three hydropower stations in the western central highland via 330 kV and 132 kV trunk transmission lines. Table 3-3 outlines the existing generating facilities and 71% and 29% of the installed capacity is provided by thermoelectric power plants and hydroelectric power plants respectively. In contrast, hydroelectric power plants accounted for 54% of the generated energy in 1995 compared to 46% by thermoelectric power plants. However, thermoelectric power plants (especially those using gas turbines) gradually became the dominant force and they accounted for 75% of the generated energy in 2005 compared to 25% by hydroeclectric power plants as shown in Table 3-4 and Fig.3-3.

**Table 3-3 Main Generating Facilities in Nigeria**

| Owner | | Station Name | Generating Method | Rated Output (MW) | Available Output (2005 Average) (MW) | Annual Operating Rate (%) |
|---|---|---|---|---|---|---|
| GENCO | Niger Hydro Power Business Unit (NHPBU) | Kainji | Hydro | 760 | 412 | 54 |
| | | Jebba | Hydro | 578 | 454 | 79 |
| | Shiroro Hydro Power Business Unit (SHPBU) | Shiroro | Hydro | 600 | 480 | 80 |
| | Egbin Electric Power Business Unit (EEPBU) | Egbin (Lagos) | Steam | 1,320 | 1,148 | 87 |
| | Delta Electric Power Buisiness Unit (DEPBU) | Delta | Gas Turbine | 912 | 393 | 43 |
| | Sapele Electric Power Business Unit (SEPBU) | Sapele | Steam | 1,020 | 105 | 10 |
| | AFAM Electric Power Business Unit (AEPBU) | Afam | Gas Turbine | 623 | 221 | 36 |
| | Ajaokuta | Ajaokuta | Steam | 55 | 25 | 46 |
| | Ijora | Ijora | Diesel | 65 | 0 | 0 |
| IPP | AES | AES | Gas Turbine | 270 | 235 | 87 |
| | Okpai | Okpai | Gas Turbine | 450 | 262 | 58 |
| | Calabar | Calabar | Diesel | 3 | 0 | 0 |
| Total | | | | 6,656 | 3,736 | 56 |

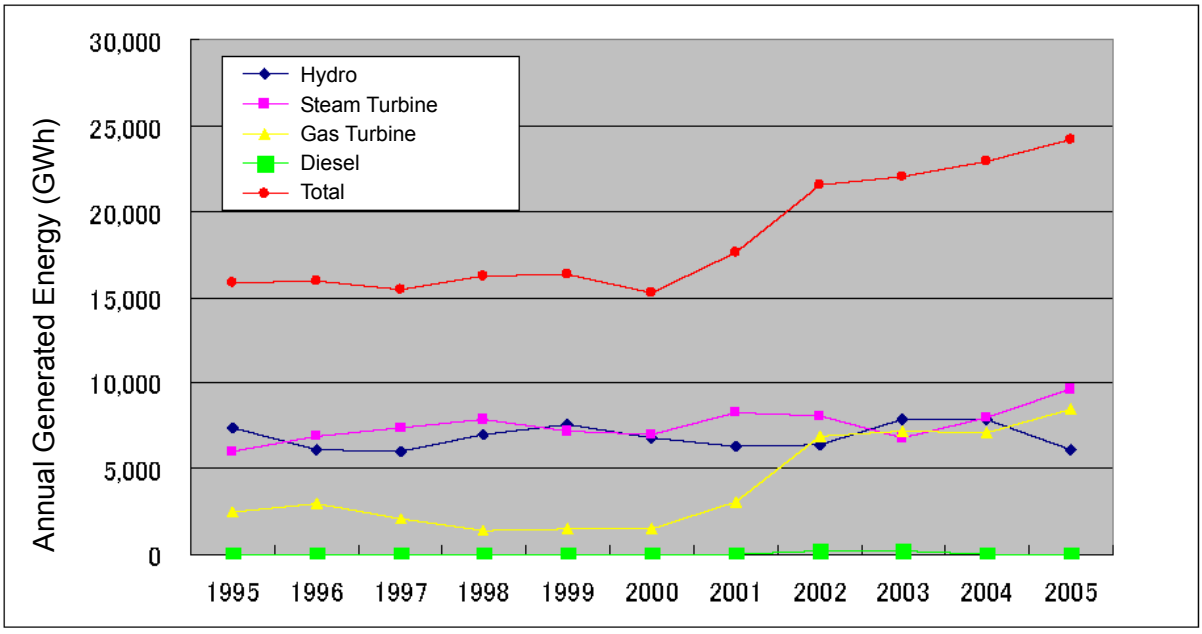
Source: PHCN

**Table 3-4 Historical Changes of the Generated Energy in Nigeria**

(Unit: GWh)

| Power Station | Type of Generation | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KAINJI | Hydro | 2,688 | 2,054 | 1,805 | 2,359 | 2,377 | 1,995 | 1,587 | 2,104 | 2,643 | 2,879 | 2,586 |
| JEBBA | Hydro | 2,708 | 1,987 | 1,937 | 2,290 | 2,807 | 2,514 | 1,991 | 2,087 | 2,571 | 2,704 | 2,268 |
| SHIRORO | Hydro | 1,940 | 2,038 | 2,229 | 2,337 | 2,435 | 2,274 | 2,678 | 2,199 | 2,531 | 2,294 | 1,236 |
| NESCO | Hydro | | | | | | | | | 78 | | 30 |
| EGBIN | Steam Turbine | 4,564 | 5,358 | 5,886 | 6,503 | 5,923 | 5,603 | 6,941 | 6,876 | 6,820 | 7,943 | 8,592 |
| SAPELE | Steam Turbine | 1,389 | 1,550 | 1,536 | 1,384 | 1,271 | 1,339 | 1,328 | 1,158 | | | 877 |
| RIVERS | Steam Turbine | | | | | | | | | | | 110 |
| AJAOKUTA | Steam Turbine | | | | | | | | | | | 81 |
| AFAM | Gas Turbine | 650 | 742 | 350 | 37 | 5 | 67 | 340 | 1,734 | 2,086 | 1,208 | 1,839 |
| OKPAI | Gas Turbine | | | | | | | | | | | 1,343 |
| DELTA | Gas Turbine | 1,853 | 2,242 | 1,669 | 1,303 | 1,473 | 1,434 | 2,140 | 3,430 | 3,536 | 3,934 | 3,235 |
| AES | Gas Turbine | | | | | | | 549 | 1,742 | 1,519 | 1,953 | 2,018 |
| IJORA | Diesel | 1 | 1 | 5 | | | | 7 | | | | |
| DALABAR | Diesel | | | | | | | | 1 | | | |
| AGGRECO | Diesel | | | | | | | | 153 | 184 | 1 | |
| GEOMETRIC | Diesel | | | | | | | | 60 | 61 | 1 | |
| OTHERS | | | | | 40 | | 1 | 2 | | | | |
| Total | | 15,793 | 15,972 | 15,417 | 16,253 | 16,291 | 15,227 | 17,563 | 21,544 | 22,029 | 22,917 | 24,215 |

Source: PHCN

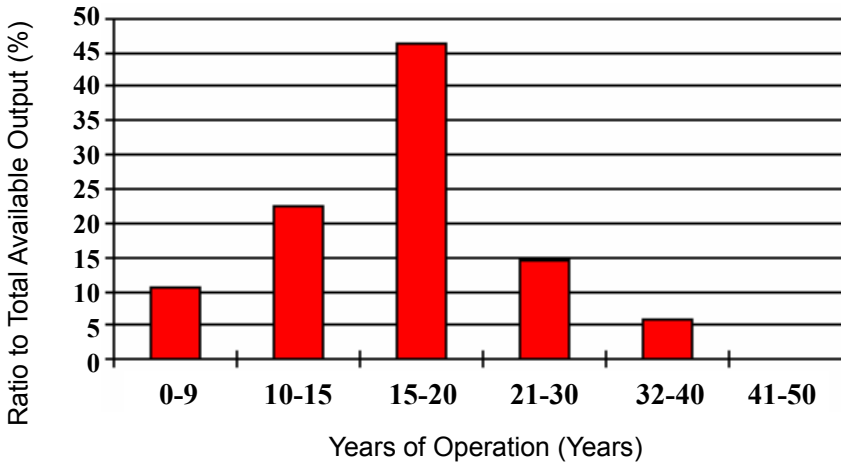



Source: PHCN

**Fig. 3-3 Historical Changes of the Annual Generated Energy**

The main power stations were constructed between the mid-1960's and the late 1980's and are now showing extreme deterioration of the equipment. Because of the lack of any reserve supply capacity, it is practically impossible to overhaul the equipment. Together with the shortage of spare parts and engineers and other reasons, the available output as of 2005 is 3,736 MW, showing a decline of the overall generating capacity to some 60% of the rated output. Fig. 3-4

shows the deteriorating situation of the generating facilities currently owned by the PHCN, some 65% of which is beyond its statutory life (15 years), making its urgent replacement necessary.




Source: PHCN

**Fig. 3-4 Deteriorating Situation of Generating Facilities**

The insufficient maintenance of the generating facilities and the suspension of new investment due to the stagnation of the Nigerian economy have made the deterioration of the generating facilities owned by the PHCN inevitable and the frequent occurrence of large-scale power failures, even in urban areas, has prompted many companies and other large users to operate their own independent power plants. In response to the deterioration of the generating facilities, the Government of Nigeria plans to rapidly introduce IPPs in the coming years to increase the installed capacity to 10,000 MW by December, 2007 as shown in Table 3-2.

**(2) Transmission and Transformation Facilities**

The trunk transmission and transformation system in Nigeria consists of 330 kV transmission lines and 132 kV transmission lines spread radially from 330/132 kV substations at various sites. Table 3-5 outlines this transmission and transformation system. The current situation of the development of the trunk transmission system is shown in Fig. 3-2. As in the case of the generating facilities, the system has the following problems due to the lack of proper maintenance and deterioration of the existing facilities, both of which are the result of the funding shortage.

- The increased power demand due to the recent advance of urbanisation and industrialisation has placed the existing system in a state of over-loading.
- The replacement of the existing transformers and other equipment and the construction of new facilities have been substantially delayed due to the funding shortage.
- Because of the fact that the transmission system runs radially without any loops or duplex feeding facilities, no back-up supply of power can be received at the time of an accident involving a transmission line.

**Table 3-5 Outline of the Transmission and Transformation System in Nigeria (2004)**

| Item | 330 kV System | 132 kV System |
|---|---|---|
| 1. Total Length of Transmission Lines | 4,684 km | 6,236 km |
| 2. Total Length of Operable Transmission Lines | 4,397 km | 6,221 km |
| 3. 330/132 kV Transformers | Total Capacity: 6,008 MVA (45 units) | |
| 4. 132/33 kV Transformers | Total Capacity: 7,585 MVA (206 units) | |
| 5. Transmission and Transformation Loss | 8.8% | |

Source: PHCN

Table 3-6 lists the breakdowns involving either a transmission or distribution line from 2004 to 2006. Most breakdowns occur with the 33 kV distribution lines and the average length of the power cut caused by such a breakdown is as long as 3 – 4 hours, making the introduction of appropriate measures to prevent the breaking down of the distribution lines necessary.

**Table 3-6 Breakdowns Involving Transmission or Distribution Lines**

| | 2004/7 | /8 | /9 | /10 | /11 | /12 | 2005/1 | /2 | /3 | /4 | /5 | /6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Breakdowns (times/month) | | | | | | | | | | | | |
| 330kV | 96 | 42 | 82 | 107 | 212 | 104 | 164 | 126 | 94 | 111 | 98 | 53 |
| 132kV | 670 | 505 | 582 | 741 | 1655 | 974 | 932 | 918 | 861 | 827 | 1,180 | 811 |
| 33kV | 7,393 | 7,392 | 7,009 | 7,608 | 8,531 | 8,536 | 7,876 | 8,287 | 8,364 | 8,725 | 10,249 | 9,494 |
| Duration of Power Cut (total hours/month) | | | | | | | | | | | | |
| 330kV | 1,198 | 568 | 1,174 | 760 | 1,280 | 711 | 432 | 530 | 356 | 685 | 235 | 198 |
| 132kV | 1,017 | 698 | 1,600 | 811 | 1,424 | 1,236 | 984 | 987 | 735 | 1,085 | 1,090 | 787 |
| 33kV | 23,388 | 21,259 | 31,202 | 20,608 | 24,283 | 26,785 | 27,044 | 26,358 | 34,173 | 28,525 | 31,692 | 30,049 |

Source: PHCN

Fig. 3-5 shows the planned expansion of the national trunk transmission grid (330 kV). According to the plan of the PHCN, the completion of the loop system for the trunk transmission lines (330 kV) and extension of the 132 kV system to major cities through the country is essential. However, the reality is that the construction of new transmission and transformation facilities has been at a standstill since 1987. As a result, the PHCN's records show collapse of the transmission system 13 times in 2003 and 14 times in 2004. The expansion of the transmission and transformation facilities is, therefore, urgently required along with the expansion of the generating facilities.