Historical Background

The Sokoto Energy Research Centre (SERC) was established in 1982 by the Senate of the University as an Energy Research Unit which was at inter-disciplinary body comprising members of staff drawn from various faculties with the bulk drawn from the Faculty of Science. The University's Research and Publications Committee funded the Research and development activities of the Unit.

Towards the end of 1982, the Federal Government decided to make the University of Sokoto Centre for Solar Energy Research. The University was informed of the decision through a letter from the Federal Ministry of Science and Technology, SFMST/ISE/206/S.1/149/50 of November, 1982 with one million naira (N1m) take-off grant. According to the letter, the newly establish Centre was to conduct research and development as well as manpower or training in solar energy.

With the establishment of the Energy Commission of Nigeria in 1988, th Commission took over the supervision and funding of the Centre. The Centre is currently located on its old and new sites in the main campus of the University. The laboratories, workshops, library, some staff offices and the testing area on the old site while the administrative block, auditorium, staff offices and Computer Room are on the permanent site.

1.0 Introduction:

Nigeria is an oil producing country and has large quantities of both natural gas and coal reserves. Nigeria supplies energy resources to Europe, USA and Asia thus helping them meet their energy needs. Today, the oil and gas export industry is the largest economic sector in Nigeria and, according to the Central Bank of Nigeria (CBN) report, this account for more than 83% of consolidated budget earnings. Any effort to abandon the intensive exploitation of this resource in the current situation will pose immense challenge both economically and politically.

At present, Nigeria uses grid-connected hydro and thermal power plants with a total installed capacity of about 30MW which does not meet domestic energy needs. Today, there is acute shortage of energy supply to cater for industries and urban cities resulting in regular interruptions of power supply. Majority of the population that lives in the rural areas are without electricity supply. Many consumers including rural dwellers, driven by the country's current economic situation and rapidly growing internal prices of energy resources, use their own sources (including cutting down trees) to generate power for energy use. As a result, organic fuels are utilized inefficiently, thereby causing damage to the environment.

The above suggests that, despite the seemingly abundant reserves of organic fuels in Nigeria (oil and gas reserves are exhaustible), there is a need to enhance the utilization efficiency of energy resources and diversify effort on the primary energy resources, such that the consumption of oil, gas, coal and forest wood will be reduced. Nigeria is well-blessed with daily solar radiation average between 4KWm/^{2}/day in the southern part and 7KW/m^2/day in the northern part. Furthermore, electricity supply from the national grid is insufficient and unreliable and majority of the population live in the rural area without electricity supply.

Environmentally clean non-conventional renewable sources of energy like solar, wind; biomass, geothermal, tidal, small hydro, etc are of vital importance as future energy sources. If Nigeria is to optimally benefit from the application of Renewable Energy Technology (RET), it must have

credible funding for research, and collaborative research between industry and academia as well as commercialization of R&D output

Since its inception, the Centre has focused its attention on the Research and development of Renewable Energy Systems, to arrest the situation of ecological problems of desert encroachment, soil erosion, and desertification through the design strategies establishment of credible R and D infrastructure, capacity building and public awareness to tackled barriers in renewable energy technologies penetration in Nigeria. Human and institutional capacity building required to sustain research and development and technical skills relevant for design, development and fabrication, installation and maintenance of RE technologies, that would meet the Nigerian challenges in energy security for the future have also been developed.

2.0 Our Vision

The vision of the Sokoto Energy Research Centre (SERC) is to spearhead the mitigation of environmental damage and alleviation of poverty through the promotion of the use of environmentally Energy source, such as solar and other Renewable Energy resources in Nigeria.

3.0 Our Mission

The mission of Sokoto Energy Research Centre is to expand the frontiers of knowledge in harnessing and utilization of solar and other renewable energy resources in Nigeria.

4.0 Mandate of the Centre

The Sokoto Energy Research Centre (SERC) was established to carryout research and development, public enlightment and information dissemination as well as manpower development in renewable Energy sector comprising of solar thermal, Solar photovoltaic, Biomass, Wind and Meteorology, Small hydropower and services, other mandate of the Centre includes:-

- To organize and carry out research in the most economical and effective means available locally for harnessing solar and other renewable energy as complementary and/or alternative sources of power;

- To investigate the appropriate designs of solar and other renewable energy equipment and appliances for domestic, agricultural and industrial uses, and to develop, produce and test prototype of same;

- To serve as Centre for the development of manpower and training in solar and other renewable energy technologies;

- To investigate the uses of solar powered-equipment in combination with other energy sources;

- To investigate the efficiencies of solar and other renewable energy systems with a view to developing more efficient ones and the problems of solar and other renewable energy storage;

- To disseminate the results of research and development efforts in solar and other renewable energy sources through seminars, conferences, public awareness programmes and the publication of directories and journals on solar and other renewable energy sources;

- To serve as a resource Centre offering advisory and research facilities especially for postgraduate work and also to offer consultancy services; and

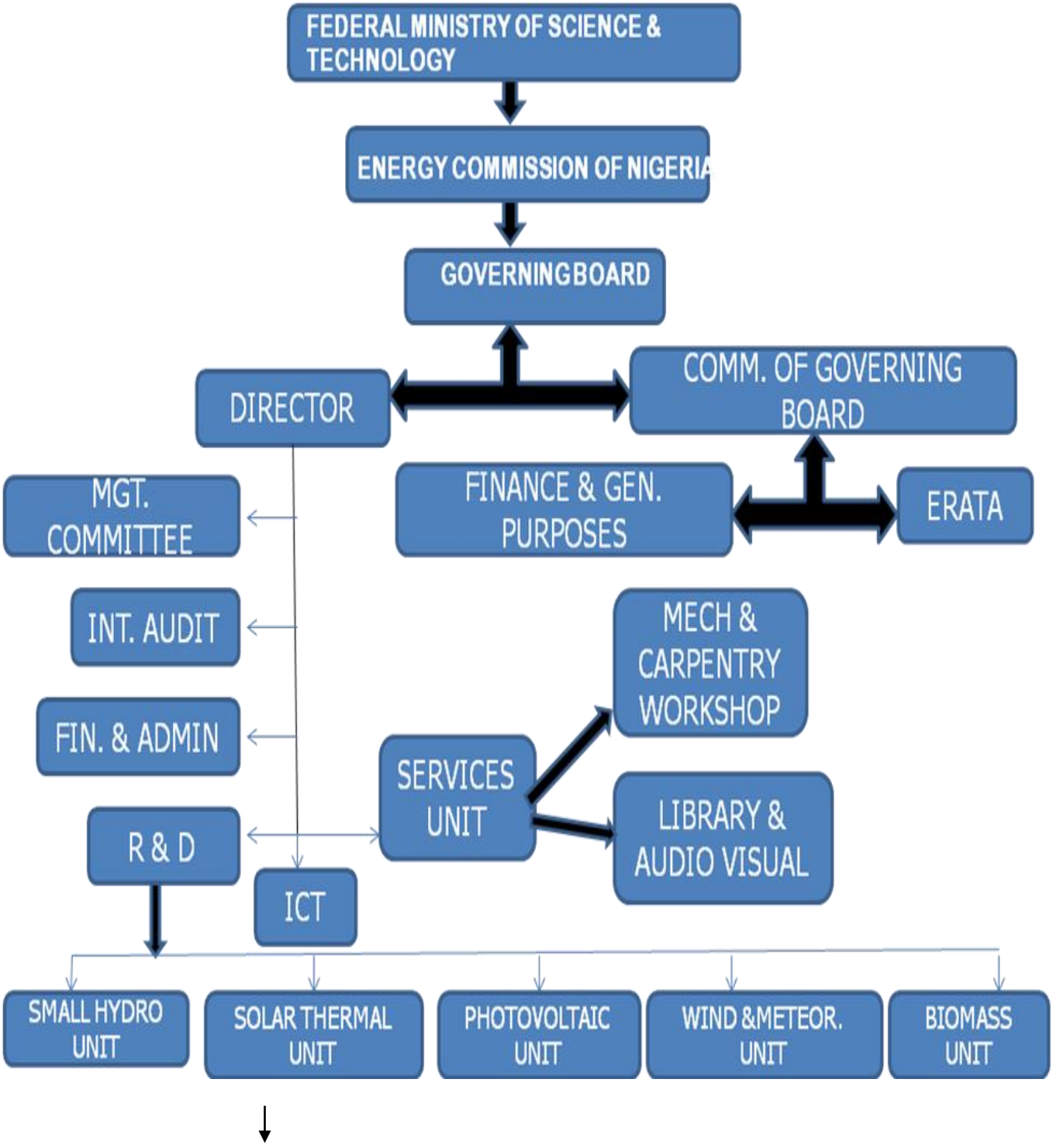
- To collaborate with similar institutions and bodies engaged in solar and other renewable energy research, development and training as joint venture partner.

5.0 Administrative Structure of the Centre

In order to ensure efficient and effective execution of its mandate, the Centre has been structured to consist of the following research and administrative units: Solar Photovoltaic; Solar Thermal; Biomass; Wind /Meteorology; Small Hydropower; Services; Administration and Finance Units. The research units operate in an integrated manner to conceive, design and executive research and development projects, while the Administration and Finance unit provide the back up.

The Centre is administered through the Governing Board, which is chaired by the Vice-Chancellor. It superintends over all policy and budgetary matters: It is responsible for recruitment, promotion and discipline of staff; it considers and recommends Centre's budget to the Energy Commission of Nigeria, which in turn considers and recommends same to the Federal Ministry of Energy, Abuja. The main committee of the Board is the Energy Research and Training Advisory (ERATA) Committee, which is chaired by the Director. It advises the Board on research, development and training activities of the Centre. The day to day running of the Centre is bestowed on the Director of the Centre in consultation with the Management Committee. In addition, the Centre has two standing committees; the Staff Appointment and Promotion Committee and the Senior Staff Committee

5.1 The Organizational Structure of the Centre



Research and Development

The development and monitoring of RET for the past decade has been possible largely through global programmes of research and development, demonstration (RDD) and financial incentives, most especially in the developed countries. The two Nigerian Energy Research Centres on Renewable Energy as well as other individuals and research groups in the institution of higher learning involve in similar research work had achieve little in the area of innovation and local manufacturing of RET. This was based on the lack of credible R&D Infrastructure for adopting and modifying imported RET and drive applicable business models. If Nigeria is to optimally benefit from the application of RET, it must have credible funding of research and collaborative research between industry and academia and commercialisation of R&D output. Nevertheless, the Sokoto Energy Research Centre`s contribution towards achieving the above objectives are gradually being materialised through the highlighted briefs below;

Biomass Unit.

Biomass unit is one of the four research units that were established since the inception of the centre in 1982, to carryout research and development in the area of Biomass and Bio-fuels, Biogas and related systems such as coal, saw-dust and improved-wood stores. Biomass as the name implies uses organic waste material of plant and animals origin directly or direct to generate fuel. Therefore, Biomass unit is charge with research in efficient utilization of these Biomass materials and related system.

Most if not all of the rural areas of the country uses wood as a major source of energy, infect even in urban centre wood in a major source of energy. The deployment of Biomass technology in generating energy could go along way in protecting our forest reserve and stifling deserts encroachment. Furthermore, most of the raw materials for generating Biogas come from waste materials use of Biomass technology will go along way in reducing environment pollution and creating a clean environment in this regard the unit has developed several Biomass related system, some of which could be seen below.

Below are some of the systems developed by the unit.

Fixed dome Biogas plant

Portable Biogas digester

Double hole saw – dust stove

Coal Stove

Community based improved wood Stoves

Distribution of improved wood stoves to Danjawa community

Biomass Systems on Exhibition

Biomass Systems on Exhibition


Biomass Demonstration Room

Solar Thermal Unit

This unit is one of the four research units that were established since inception of the Centre in 1982 to carryout research and development in the use of direct solar radiation for various applications such as solar drying, solar water heating, solar distillation, solar cooking etc.

Nigeria lies within a high sunshine belt with solar radiation incident on the earth at the rate of about 2.0×10^3 Kwh / day, its intensity varies with location, season, day of the month and time of the day. Solar radiation varies from about 3.5 kwh.m2/ day in the coastal latitudes to about 7.0 Kwh/m2 / day in the far North.

Solar thermal technologies, particularly for water heating, drying and cooking has been one of the most promising areas of solar been energy application, and already competing on equal terms with other sources of energy in many countries of the World. The Sokoto Energy Research Centre had over the years, designed, developed and installed a number of these systems at proto level, pilot and large-scale application. Currently, the unit had fabricated tested these systems to level of commercialisation.

Below are some of the solar thermal systems developed by the Unit.

Spiral solar water heater

Community based solar water heater

Parabolic Solar cooker

Box Type Solar Cooker

Solar Distiller

Concrete Solar Distiller

SERC Systems on Exhibition at Nastech

Photovoltaic Unit.

The Photovoltaic unit has the main objective of carrying out research and development activities in the area of solar Photovoltaic Technology, some of the area being considered include, Solar Cells material and Technology, Inverters and Charge Controllers, system design and Implementation among others. The unit comprises of both Research and Technical Staff.

Photovoltaic Technology converts sunlight directly into electricity by the use of solar modules. The solar modules are made up of solar cells connect in series and parallel to increase voltage and current. Solar cells produce direct current electricity from light, which is use to provide power equipments or to recharge battery bank.

The first practical application of solar photovoltaic was to power orbiting satellites, spacecraft, and pocket calculators, but today the majority of solar photovoltaic modules are used for stand- alone, mini- grid, grid applications. The unit had carried out studies in different type of modules and developed many research and pilot projects in photovoltaic application, below are some the projects.

7.2 Kw Danjawa Solar PV Electrification

Solar Water pumping at Birjingo community

2 Kw Solar PV back – up UDUS Internet System

4.5 Kw Solar PV electrification at SERC

Solar PV Demonstration Room

Solar PV street light at SERC permanent site

Solar Water Pumping Demonstration at SERC Permanent site

Meteorology / Wind Unit

This Unit is responsible for studies and keeping record of weather events, which illuminate and are, explains by the science of meteorology. Those events are bound by the variables that exist in the Earth atmosphere. Temperature, Wind, Insolation, Humidity, Rain etc.

The unit serves as the data bank base for the centre, all the research unit depends on the data collected by this unit, for design of all their renewable energy systems. Below are the photographs of some of their measuring equipment install at the centres testing area.

The unit is also in charge of carrying out research development and man- power training in the wind energy conservation systems. In this area the unit has been carrying out designs, constructions, installations, testing and monitoring of different Wind energy conservation system consisting of vertical and horizontal axis types.

(DL_2E Data logger Station)

5KV wind electricity generation plant

Meteorological instrument installed at SERC

Local Radiation Sensors for measuring Meteorological instrument installed at SERC (Direct & Diffused Radiation)

Proto-Type of Wind Turbine

500W Hybrid Wind/Solar Power Constructed by the Centre

Pilot project carried out included 5KW capacity wind turbine of 2.5KW each installed provide electricity to Sayya Gidan Gada village, near the permanent side of Usmanu Danfodiyo university Sokoto. The unit has the capability of designing and constructing of wind turbine locally available materials. The unit has also been providing consultancy service as well as offering hands-on-training to other governmental and non-governmental organizations. Recognizing the efforts or capabilities or the unit the national Directorate of Employment (N D E) sponsored training of some unemployment graduates in Benue, Gombe, Katsina, and Sokoto States, Fig.4 and Fig.5

respectively shows the locally constructed 2.4m-500W wind turbine locally constructed and some one of the state training sections.

Collaboration

The center is in collaborative partnership with center for basic space science UNN and other relevant research institute across the country.

Small hydropower Unit

Small hydropower unit was established in 2004 with the objective of conducting research into and carrying out development of small hydropower potentials on the Sokoto and Rima Rivers particularly in Sokoto, Kebbi and Zamfara States. The unit has a laboratory for conducting research, testing and demonstration with which it has identified some potentials SHP sites in Sokoto and Rima Rivers and will soon embark on the verification and updating of these sites in order to determine the various heads available at these sites.

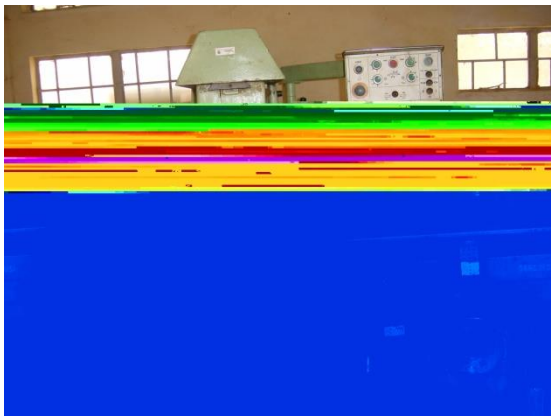
The unit has developed and tested a laboratory simulated model of a hydro-electric power plant. This is for the benefit of young and upcoming students interested in hydro-derived renewable energy.

The unit has also developed and is currently testing a model of a hydro-electric power plant with an overhead water tank simulated head. After testing, the plant is intended to be a model for rural electrification. Below are photographs delineating the unit's laboratory and simulated/developed model plant.

SHP Demonstrating System Locally Fabricated at SERC Demonstration Area

Services Unit

This unit is responsible for constructions of all the renewable energy systems developed by all the research units of the Centre. Below are photographs of some of machines used for the construction at workshop.



Leather Machine

Power drilling Machine

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) UNIT

The Centre has provided Information and Communication Technology (ICT) equipment to the entire two sites of the Centre. ICT access Laboratory and other facilities for research purposes such as Internet access, Projectors, Scanners and other materials are made available. Staff salary and Staff Information Systems are automated and made available at all times. The Unit has a VSAT, Very Small Armature Terminal and Radio Frequency wireless Network to provide services to the Centre.

All the research activities in the Centre are online and the staffs are equipped with the necessary skills to conduct online research in line with the Centre ICT objectives which are:

1. To provide conducive environment equipped with ICT facilities for effective research activities.

2. To provide the researchers with necessary infrastructure for effective communication at all locations within and outside the Centre.

3. Access to Networks at all levels for collaborative research.
4. Provision of reliable data management system on research conducted, staff and financial records.
5. To provide necessary skills required for operating and managing the ICT equipment in the Centre.

Below are photographs of ICT equipment and facilities installed at the Centre

Network Servers

V-SAT at the Centre

Computer Lab.

Computer Lab.

Data Processing Work Station

Sokoto Energy Research Centre, Usmanu Danfodiyo University Sokoto

6.0 Linkages

The Centre through the Energy commission of Nigeria entered into a linkage agreement with the School of the Built – Environment, University of Nottingham, England, for the training of its staff. Already, three staff of the Centre had benefited from the programme.

7.0 Postgraduate programme/studies

To sustain Human and institutional capacity building for science, engineering and technical skills relevant to design, development, fabrication, installation and maintenance of Renewable energy technologies RETs, the Sokoto energy research center in conjunction with chemistry department had commenced since November, 2008 postgraduate programmes (M.Sc, M.Phil and Ph.D degrees) in renewable energy studies. The centre had successfully completed the course work for M.Sc and M.phil for Ph.D for the two sessions and the students have been allocated with supervisors and supervisory advisory committee. The introduction of postgraduate studies is aimed at development of critical mass of scientist and engineer for R and D and manufacturing capabilities in renewable technologies for both secondary and tertiary institution.

8.0 STEPB Centre of Excellence in Renewable Energy Research and Development

The Federal ministry of Education`s Science and Technology Education post Basic (STEP B) project, has granted a provisional" No objection" that the University, through the Sokoto Energy Research Centre (SERC) , be supported to emerge as Centre of Excellence in Renewable energy research and development. The proposal from the Centre for establishment of the Centre of Excellence competed along with over 100 other proposals from various educational and Research

institution in the Country. The funding will provide the Centre with financial support to the tune of four million, two hundred thousand dollars ($4,200,000:00) only. The Centre in collaboration with other relevant institution stated in the proposal is aimed at becoming a leading institute in Research innovation and capacity building in different areas of Renewable energy technologies based on current state of development.

9.0 Establishment of Model Rural city through the Application of Integrated Renewable Energy Systems.

In line with mission and vision of the Centre, in expanding the application of knowledge through research and development, training and public enlightment in solar and other renewable energy technologies. The Centre had reached advanced stage in the establishment of the rural model city at the centre fully run by the application of integrated renewable energy systems RE of Solar thermal, solar photovoltaic/ wind hybrid system , Biomass systems (comprising of switch grass and Jatropha for bio –diesel and biogas, for cooking and electricity generation as well as energy plantations). The model city is aimed at stimulating the public on the practical use of integrated renewable energy systems in transformation rural areas into city through the application of different renewable energy systems

10 .0 Pilot Projects

In order to provide organized forms of illustrating community-based utilization of the Centre's Research and developments, the Centre has embarked on the establishment of pilot projects Nation- wide. These pilots' projects also provide direct physical evidence that renewable energy technologies are indeed ready for community utilization. The pilot projects are also aimed at dissemination of the practical application of renewable energy technologies for the people. Since inception, the Centre had established over one hundred and ten (110) pilot demonstration projects that cut across the various aspect of renewable energy technology across the Country..

11.0 Consultancy Services

Apart from the pilot projects described above, the Centre has been carrying out Consultancy Services to government and private organizations in all aspects of renewable energy. Prominent among which is the feasibility report on the use of solar energy for Jigawa State Government in 1994. Subsequently the state has decided to, based on the report submitted, to convert its entire borehole schemes from diesel powered to solar powered. The Centre was also commission in 2003 by the ETF to serve as consultant for the solar electrification projects in fifteen schools across the country. Furthermore, the Centre had undertaken consultancy services for UNESCO, UNDP, UNIDO and PHCN; additionally, the centre had recently served as consultant to the following organization;

- Consultant for Solar/Wind Hybrid System in 70 different locations in Zamfara State.

- Training communities on Solar Street Light and Solar Water Pumping Systems for the 2009 constituency Project.
- Training on design, sizing, and installation of Solar PV Systems jointly organised by the centre and National Directorate of Employment Abuja, for the training of 400 Unemployed Graduate.
- Training of 140 Unemployed Graduate on Construction and Installation of 300W/500W Wind turbine from Benue, Gombe, Katsina, and Sokoto States Sponsored by National Directorate of Employment NDE.
- Feasibility Studies Solar PV application in MFEYE Vallage Calaba, Sponsored by UNDP/PHCN.
- Supervision of Solar PV Diginete Lab. In 15 locations across the country sponsored by ETF.
- Feasibility studies on Solar PV applications in Jigawa State sponsored by Jigawa State Government.

12.0 Constrains

- Inadequate funds for Research Projects
- Inadequate funds for acquisition of research fertilities.
- Inadequate funds for manpower training.
- Entrepreneurs not showing interest in commercializing already developed Renewable energy system