A DESIGN PROPOSAL FOR SOLAR ENERGY RESEARCH CENTRE ABUJA

With emphasis on natural ventilation

By

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AWARD OF M.TECH DEGREE IN ARCHITECTURE.

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DECLARATION

I, Awuah Poku Baffour of Department of Architecture, School of Post Graduate Studies, Federal University of Technology, Minna, declare that this thesis report is the product of my research work and has not been presented either wholly or partially for any degree nor being currently submitted for any degree programme. All sources of information and quotations are duly acknowledged.

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CERTIFICATION

This thesis report titled "**DESIGN PROPOSAL FOR SOLAR ENERGY RESEARCH CENTRE, ABUJA"** meets the requirement governing the award of M.Tech (Architecture) and approved for its contribution to knowledge and literacy presentation.

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H.OD ARCHITECTURE	
....	....
EXTERNAL EXAMINER	**DATE**
....	....
PROF ABALAKA	**DATE**
DEAN SCHOOL OF POST GRADUATE STUDIES. F.U.T. MINNA.	

Dedication

I dedicate this publication to my loving parent presently abroad especially my mum.

Mum, it is your spirit that has kept me alive.

To my God parent Mr. & Mrs. Buachie,

And lastly to my loving brother and sisters, Janet, James, Lynda and Neomesia.

Acknowledgement

Firstly I will like to praise our most adorable loving God for sparing my life. He made what looks impossible at the begging to be ordinary. I will like to acknowledge my parents for all the respect into my academics. God bless them as they sow in Jesus name.

My gratitude goes also to the families of Mr. Buachie for all his tireless effort for me; same goes to mama and my unforgettable sister Neomesia for her encouragement.

My uncovered and sincere gratitude goes to my mentor and above all my inspirator, Architect R. E. Olagungu whose invaluable contribution, untiring effort are careful molding actualizing my architectural dream to reality to minimum stress. I will like to acknowledge the various forms of assistance and encouragement given to me by members of staff of the department. They include the head of department in person of Dr. (Mrs.) Stella Zubairu, Dean of the school of Environmental Technology, Professor Jide Solanke whose valuable contributions had helped me so far. my acknowledgement is incomplete without mentioning the effort of Architect Mrs. Bakaya and the ever tireless Architect Aniya who had scaled me through various degree of training.

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My profound gratitude goes to my friend Elvis whose help has pushed me to completing this project.

I would like to also thank all those who have made my stay in Nigeria comfortable.

ABSTRACT

The solar radiation levels are lower at the coastal areas and higher in the northern parts of the country with the northeastern states having higher solar radiation levels all the year round. Chapter one of this thesis gives you an insight of the probable problems facing the country as regards trying to educate the people into using the abundant resources, which is of course the sun light as a means of an alternative energy. It gives a brief introduction into the advantageous use of solar energy, as well as lining up the aims and objective of the project. Chapter two goes on to highlight facts on the historical development of solar energy, it origin, how far it has gone in Nigeria, development and application of the solar energy. Chapter three is basically on the research area, which is natural ventilation. Since humans enjoy an environment, which is thermally comfortable, the above area will look into possible ways by which thermal comfort can be achieved through natural ventilation. Chapter four highlights an area of data collection, which aided in the design proposal. Data collection in the form of case studies. Chapter five provides basic information on the climatic conditions of the site while chapter six gives details on the analysis of the site. Chapter seven gives a brief summary on the design report and chapter eight explains the design services used. Chapter nine summarizes the project and gives a brief recommendation. Nigeria's abundant availability of sunshine offers great promise for meeting rural and even urban alternative energy needs in the country.

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CHAPTER ONE

1.0 INTRODUCTION

Nigeria's commercial energy sources consists mainly of fossil fuels:- oil, coal and natural gas, wood fuel accounts for over 50% of the overall energy consumption in country. The estimated reserve of the above energy sources in the country are as follows: oil, 18.20 billion barrels; cost 270-980 million tones natural gas, 2.7-8.1 billion barrels (100-300 trillions cubic feet (TCF) which is equivalent to 15 billion barrels of oil; wood fuel, 43.3 million tones per year.

Electricity in Nigeria is produced mainly from fossil fuels and hydro. Hydro energy is the second major source (43.04%) of the national grid electricity. The distribution pattern of the national grid electricity in Nigeria is centered mainly in the urban areas. Electricity is used mainly in residence, industries and establishments. Petroleum also has use in the country's transportation system.

About 80% of the rural population have no access to modern electricity and still rely mainly on wood fuel, charcoal, kerosene, and agricultural and animal wastes for their energy requirements. There is therefore still inefficient rural energy utilization and consequently; low standard of living in the rural areas in Nigeria. In spite of the vast availability of conventional energy sources in Nigeria, there is still inefficient energy utilization in the country. The reasons include: the mismanagement of available conventional energy sources resulting to incessant energy crises in the country and the decline production capacity of conventional energy due to the worsening economic situation in the country.

Nigeria is endowed with abundant availability of sunshine of not less than 11 hours per day throughout the season of the year to meet the alternative energy needs especially in the rural areas but which is still not being well utilized or developed. Fortunately, over, there has been increasing awareness of the important roles solar energy utilization for national development in the country. Solar scientist at the energy research centers has promoted research development and application of solar energy at the energy research centers, universities, polytechnics and other institutions in the country. The establishment of the solar energy society of Nigeria (SESN) which was launched on the 11 July 1980 at the Hotel Presidential, Enugu with Professor A.O.E. Animalu, Professor of Physics at the University of Nigeria (UNN), Nsukka as the first president during the symposium on solar energy development in Nigeria held from 11-12 July 1980 at Project Development Agency (PRODA), Enugu then under the directorship of Professor G.O.Ezekwe had also assisted in this direction.

This forum then brought together for the first time scientists, engineers and technologists that had been working in the field of solar energy in various institutions in the country. The National Centre for Energy Research and Development (NCERD), university of

Nigeria (UNN), Nsukka and the Sokoto Energy Research Centre (SERC), Usman Danfodio University (UDU), Sokoto were particularly established by the government in the early 1980 to undertake research and development for application on not only solar energy but also on wind, Biomass and Biogas energy.

Solar energy utilization may not replace other conventional energy utilization in Nigeria but its promotion has the following advantages:

i. Due to the Universality, inexhaustibility, abundance and free availability of solar energy systems can be installed on- site as stand alone, decentralized or centralized systems at needed areas with no electricity without fuel cost. The cost of fuel, fuel transportation, fuel tanks distribution network and frequent fuel crises due to incessant poor management of conventional energy could be eliminated. The nation's reserves of fossils and wood fuels, desert encroachment, soil erosion and desertification due to wood fuel utilization in the country could be saved.

ii. Solar energy utilization does not create environmental pollution products or wastes.

iii. Solar energy device systems have no moving parts. They operate unattended at ambient temperatures with no noise. They are easily installed and maintained permit energy storage e.g. lead acid batteries

iv. Solar energy utilization will enhance industrial activities and create new jobs in the rural areas. The productivity economy and the standard of living of the rural population, which will improve the populations draft from the rural to urban areas to be reduced.

v. There is also vast land exist in most areas for the installation of solar energy systems

1.1 PROBLEM IDENTIFICATION

Energy transmitted from the sun in form of electromagnetic radiation is the source of all solar energy. The major concern in solar energy research programme today is how to store large quantity of energy commission world wide, and Nigeria is no exception being a prominent member of the international Solar Energy Agency.

The establishment of solar energy research commission over a decade ago is a national response towards the realization of solar energy development in the country, as an alternative of fossil fuel.

The solar research agency is charged with the following responsibilities, namely: -

i. To organize and carry out research in the most economical and effective means available locally for harnessing solar and other renewable energy as complimentary and/ or alternative sources of power.
ii. To investigate the appropriate design for solar and other renewable energy equipment and appliances

for domestic, agricultural and industrial uses, and to develop, produce and test prototypes of it.

iii. To serve as center for the development of manpower and training in solar and other renewable energy technology.

iv. To investigate the efficiency 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.

v. To investigate the use of solar powered equipment in combination with other energy sources.

vi. To study environmental factors affecting solar and other renewable energy harnessing and for this purpose to establish and maintain filled stations elsewhere in the federation for experiments and data collection.

vii. To study the energy conservation possibilities in various sectors of energy consumption and to encourage prudent energy management principles.

viii. To study socio-economic parameters related to popularization and mass adoption of solar and other renewable energy systems.

ix. To serve as a resource center offering advisory and research facilities especially for post-graduate work and also to other consultancy services.

x. Finally, to cooperate with institutions and bodies engaged in solar and other renewable energy research, development and training and to collate and or coordinate their work whenever practicable.

In view of this, the solar energy research center will be established with the increasing technological complexity of passive solar thermal system and lack of standard architectural environment for effective solar research programme.

Though the issue of energy in architecture has always been debatable, notwithstanding, as a science of the built environment, Architecture has always provided services to energy industry energy types such as electrical, mechanical or radiation transmittance depending on the environment and climate require architectural design to facilitate both research and development.

1.1 MOTIVATION

The continuous challenge to energy, incessant electricity power failure and scarcity of fossil fuel poses a threat to the people. Socio-economic development can only be enhanced when there is a steadily available energy source.
The need to improve the living standard of the people is the major motivation of this study.

As a result this, the prospect of renewable energy sources is being examined as a more efficient and economical means.

Among other things, solar energy also has the following important advantages: -

i. It is inexhaustible
ii. It will reduce over dependence on fossil fuel consumption.
iii. It is an insurance against an unpredictable future.
iv. When employed, it is evident that the hope of sustainable energy is in Solar Energy. This is the essence of the solar energy research center.

1.3 AIMS AND OBJECTIVES

The goals of this research are: -

1.3.1 Aims

i. To undertake an intensive study on the architecture of passive solar energy research to propose a state of the art design for the energy research center in Abuja.

1.3.2 Objectives

i. To suggest architectural solution using solar energy as alternative sources of energy.
ii. To highlight the prospect of solar energy as a suitable energy source by setting examples on the proposed center.

1.4 SCOPE LIMITATION

The scope of this thesis research is to design an energy reach center in Abuja, the capital of the federation. The design will lay emphasis on the architectural solution to integration of functional spaces for research convenience, as applicable to provision for research and development activities such as laboratories, Meeti well as Residential accommodation for temporary staff.

Finally, there is also going to be a thesis write-up, which will highlight other theoretical factors, such as introduction, design report, a general survey, design concept and the general situation of the site.

1.5 RESEACH METHODOLOGY

In the course of this research, information and data shall be collected from primary and secondary sources. An investigation into the environmental impact analysis of the center would be considered. Besides, a comprehensive library research, which involves consultation of books, past unpublished thesis projects, architectural journals, papers and seminars related to the filed of study will be employed.

A rigorous field research will be carried out, this includes traveling to Abuja to study the existing site situation and to carry out relevant surveys, photographs, climatic data and personal observation shall be recorded and finally analyzing the climatic data to know the existing prevailing climatic conditions of the site so as to integrate or synthesize the proposal into the existing climatic conditions.

1.6 ARCHITECTURAL SIGNIFICANCE

The architectural significance is the creation of a center, which is energy conscious. It can be better conceived as a structural convenience designed to embrace research on the potency of solar energy and other renewable energy technologies. Functional spaces will be provided to encouraged development program as well as facilities for training Nigerians on the benefits of solar energy. This center will no doubt act as an arena for exchange of scientific ideas.

Finally, the research takes cognizance of the solar energy potentials of Abuja, which is the study area. It intends to identify the suitable forms, materials and finishes that will be needed in the solar energy center.

1.7 CONSTRAINTS/LIMITATION

Despite the fact that Abuja is quite some distances from Minna, effort would be made to conduct a through investigation on the subject matter so as to justify the thesis proposal. It will be very helpful to carry out many more case studies in other Energy Research Centre.

Lack of adequate facilities in getting current information on foreign Energy Research Center as case study but some secondary sources of information could be of significant assistance.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 HISTORICAL DEVELOPMENT OF SOLAR ENERGY

2.1.1 The Sun

The sun is made up of an extremely hot gaseous matter and it is the source of heat and light for the entire solar system. Fueled by thermo nuclear fusion, the sun radiates energy into space at tremendous rate. Less than one thousand of a millionth of this phenomena output intercepted by the earth as it progress round the sun at about 150 km s away. The sun's ray takes about 8 minutes to reach the earth surface. This sun's ray bath the earth in heat, determines our weather.

2.1.2 Solar Energy

Solar Energy is a relative new field of scientific technology endeavour and particular so in Nigeria.

Petroleum products are the main stay of Nigeria economy and so far the main sources of energy for the world. But proven discovered reserves indicate that petroleum reserve is last forever. Thus, the need to start looking for alternative sources of energy becomes vital.

There is no better alternative than the energy from the sun. As long as there may be no life on earth. The sunshine, is unlimited inexhaustible, clean and has relative no pollutant. Nigeria has a large area of land mass and is Geographically located in the tropics. Therefore, the amount of sunshine is enormous.

Solar energy arrives at the top of the earth's atmosphere at a very close to constant intensity. However, on the earth's surface, this constant is known to vary from place to place and from time to time due to meteorological uniqueness. The average intensity on the earth's surface is 1000w/m2. Dr. Gulma and his company have estimated the total solar power density of Abuja as 984 w/m2 as measured in 1982.

Cloud and weather patterns vary and attenuate the Solar Radiation in traversing the atmosphere. Therefore, we would expect to find a region that has generally cloud free weather, such as the dry region of the F.C.T to receive greater solar energy. Water vapour , haze dust, and other atmospheric contaminants tend to decrease the solar energy available at the earth surface. As long as this quality varies with altitude the solar energy varies with altitudes. Solar radiation can be measured as direct diffused or total radiation.

2.1.2 Origin

All our fossil fuels were created from the sun and this fuel and energy that have been stored over a long period. In fact millions of years ago chemical reaction stimulated by sunshine, form all fossil fuel. The oil and natural gas are now tending as conventional fuels. The non-conventional fuel also known as renewable energy source include nuclear energy, solar energy, biomass, geothermal, hydro-electricity, sea tidal and wave energy.

Energy has been the medium to man greatest goal and to his dreams of better world. It is sometimes said that a cave man stated along the path of civilization after he utilized the energy in fire for heat and light, and the energy in his body food and survival. In the centuries since then, man quest for material well-being has been tied liable to the harnessing of various form of energy for one purpose or the other.

Today world is living in a very dynamic time of history. A time when worldwide catastrophe could lie shortly before us in the areas of population's explosion energy shortage, pollution and other environmental effects and shortage of food supply, unless worldwide control measures are implemented. There are many other implications but the principle implications are regarding energy.

2.1.3 Survival

The share hardship of life made man to look for tools and weapon to get food he wanted so as to increase the power, efficiently arranged of his own hands. From that age perhaps a million years ago dates the beginning of his mental and physical development, which sets him apart from other animals and started him on the road to supremacy on earth.

Energy is the crucial pillar of progress and it is prime requirement for civilization to survive. Availability of cheap and supply of energy is an index of the prosperity of any nation. The per capita consumption of the country indicates the standard of living of the people. Rapid industrialization and rising standard of living have caused the demand for fuel to increase.

2.1.5 Solar Cell

A semiconductor electrical junction device, which absorbs and converts the radial energy of sunlight directly and efficiently into electrical energy, is used. Solar cell may be used individually as light detectors, for examples in cameras, or connected in series and parallel to obtain the value of current and voltage for power generation. Most solar cells are made from single crystal silicon and have been very expensive for generating electricity but have found application in space satellite and remote area where low cost conversional power source have been available.

Research as emphasized lowering solar cell cost by improving performance and by reducing materials and manufacturing cost. One approach is to use optical concentrators such as mirrors or Fresnel lenses to focus the sunlight unto smaller area solar cells.

2.1.6 Solar Radiation

The intensity and quality and quality of earth's atmosphere from that on the surface of the earth is quite numerous. The number photons at each energy is reducing upon entering the earth's atmosphere due to reflection, to scattering, or to absorption to water vapour and other gases. On clear days the direct radiation is about 10 times greater than diffused radiation, but on overcast days the sunshine is entirely diffuse. The mean annual solar energy falling on the earth's surface varies greatly from one location to another. The sunniest region of the globe receives about 2500KWh/m2 per year of total sunshine on a horizontal surface. The earth receives about 80 x 1012KWh, so that from a purely technical viewpoint, the world consumption corresponds to the sunlight received on about 0.008% of the surface of the earth.

rainfall in the year than other parts of the country. They increase from the south to the north. They are higher in the northern parts of the country, which are semi-arid, and with less rainfall in the year. The northeastern states of the country, all the year round a. receive greater percentage of the country total average of 5.5kwh/m2 day of solar radiation from the sun.

2.3 BARRIERS TO SOLAR ENERGY UTILIZATION IN NIGERIA

The barrier hindering the rapid utilization of solar energy in Nigeria include the following:

The poor technical and industrial bases and the bad economic situation in the country which are resulting to the high cost of imported solar energy systems and materials; lack of sources of funds or incentives; the low level of government involvement in solar energy projects; environmental impact such as the attenuating effect of the night, clouds, rain (humidity) and the harmattan dust on solar energy; poor road systems to the most remote rural area; lack of adequate information on solar energy systems to improve the awareness of the people on the benefits of solar energy utilization.

2.4 RESEARCH DEVELOPMENT AND APPLICATIONS IN SOLAR ENERGY IN NIGERIA

Through research and development over the previous years, solar energy has gained acceptance for application especially in the rural area in Nigeria. The main areas in which research development and application are being undertaken are solar thermal and photovoltaic applications. While researchers at research institutes are concerned mainly with research and development for application, companies have already been installing solar energy devices e.g. photovoltaic systems in various parts of the country.

2.5 SOLAR THERMAL APPLICATIONS

In solar thermal energy conversion, solar energy is first converted to heat. The energy is either used directly or converted into cold, electrical or mechanical forms. Researches have shown the capability to design and install some thermal systems for solar energy utilization especially in the rural area in Nigeria. Some of these solar energy systems will be discussed below.

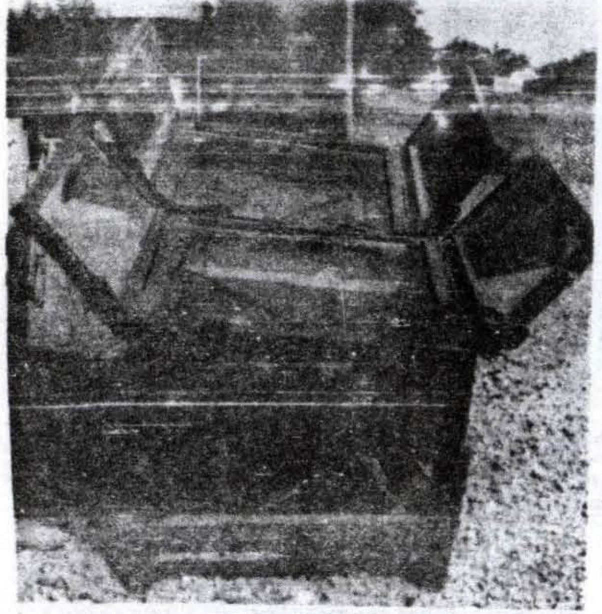
2.5.1 Solar cookers and ovens

Solar energy can be a good alternative energy for cooking and baking of food. Solar energy utilization for cooking and baking may not replace the use of other cooking fuels but would rather complement them due to the reasons that include its unavailability at night and also its low intensity during cloud, rainy or the harmattan periods of the year. Solar cookers and ovens are not yet widely utilized in Nigeria. The promotion of solar energy utilization for cooking and baking will help to reduce the hardship

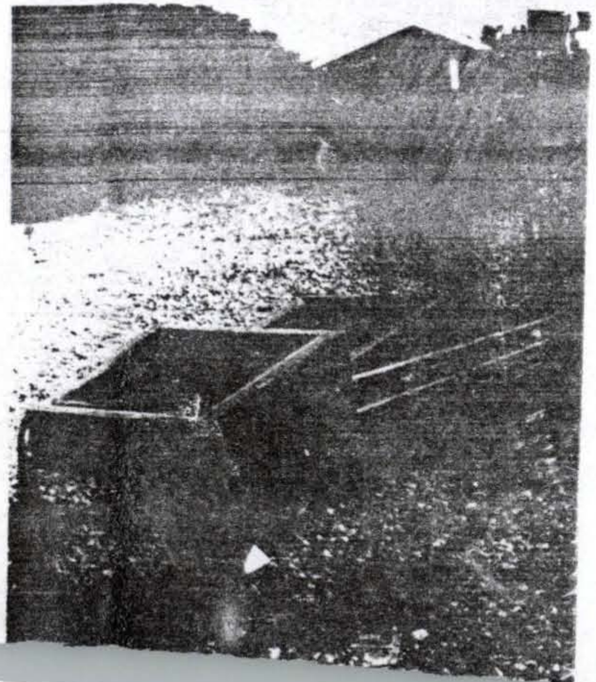
2.5.2 Solar thermal refrigeration system and heat pumps

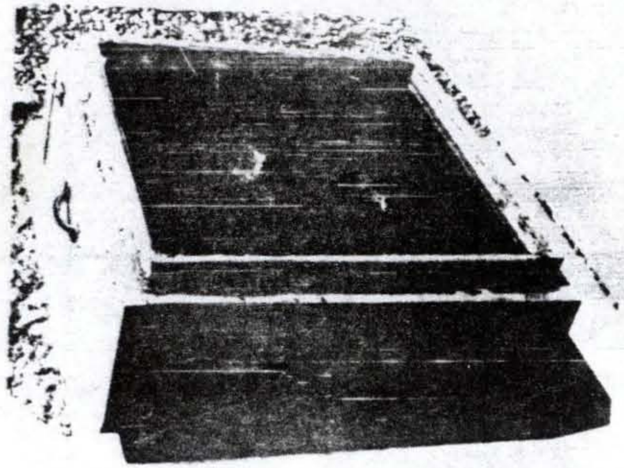
The method of preservation of food items and medical facilities especially in the rural areas in Nigeria are not still adequate. Solar energy has potentials for the powering of refrigerator and heat pumps for the preservation e.g. medical facilities in rural health centers in Nigeria.

Researchers in Nigeria have developed solar powered ammonia heat pumps and refrigeration systems for cooling a solid absorption refrigerator with calcium chloride as absorbent mixed with 20% CaSo4 to bind particles together and ammonia as refrigerant. Solar thermal refrigerators and heat pumps are not yet finding widespread utilization in Nigeria. The widespread of this system will help to

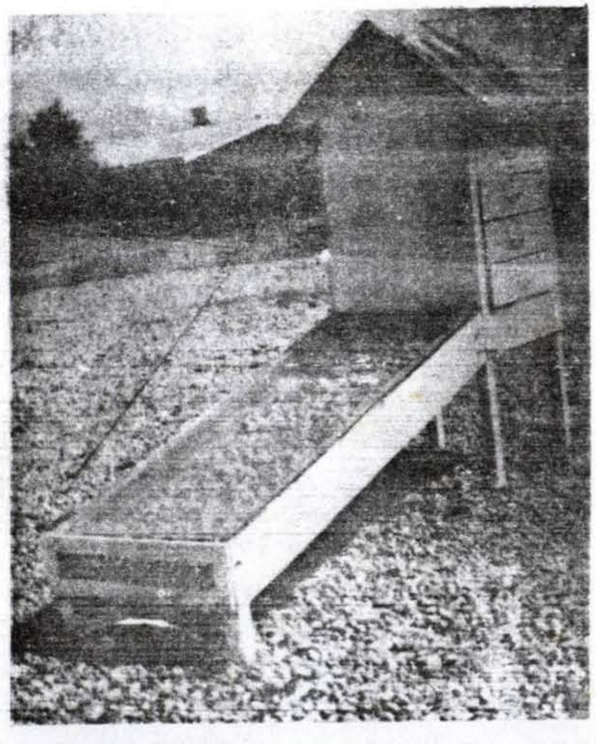


4. Spiral Collector Solar Water Heater

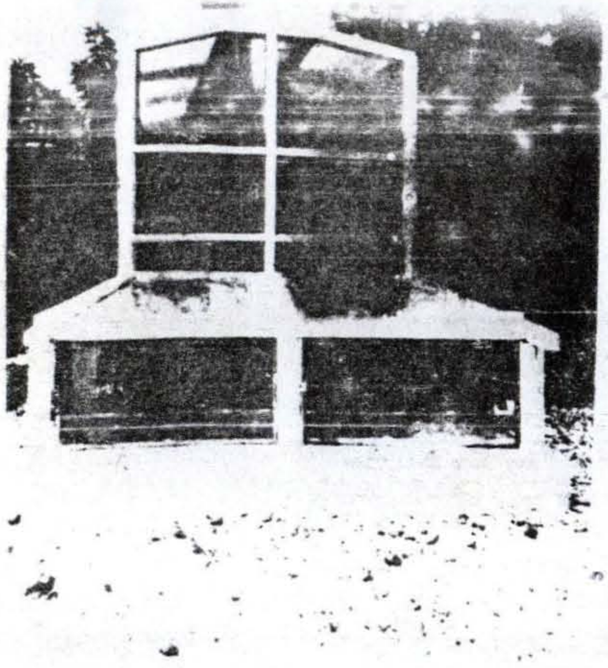




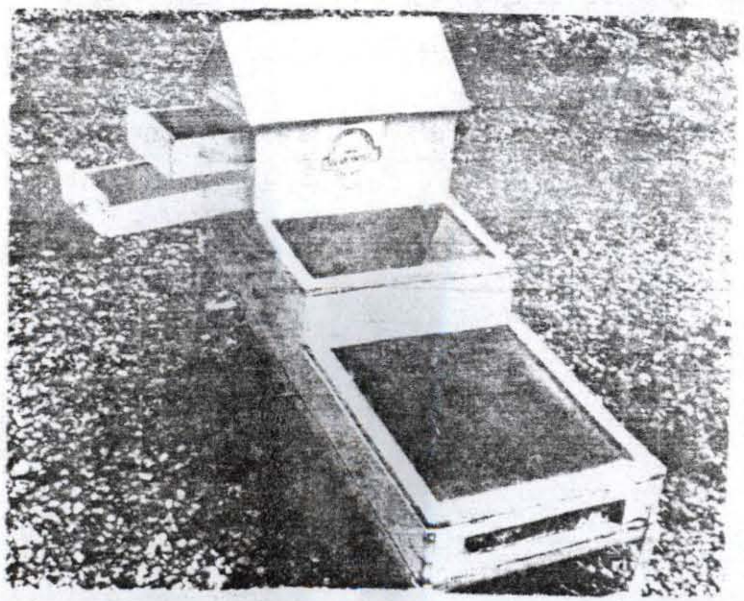
6. Fish or Meat Dryer



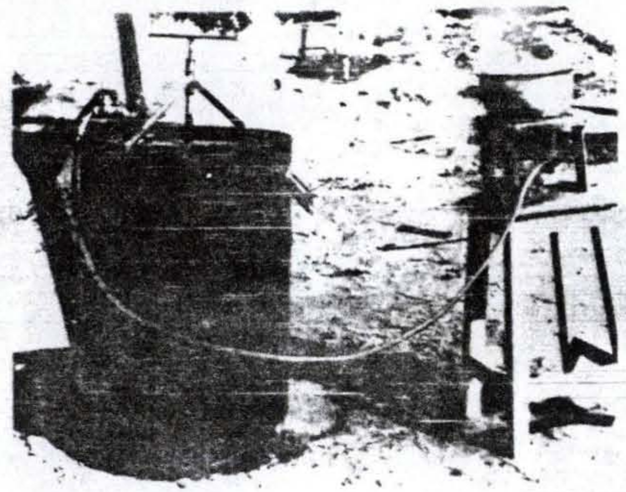
7. Indirect Solar Dryer



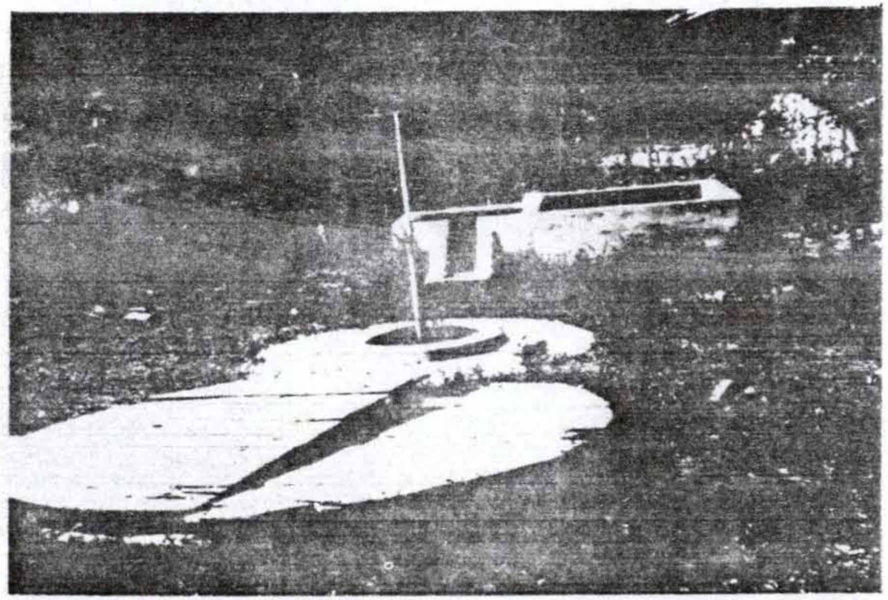
8. Combined Mode Large-scale Solar Dryer



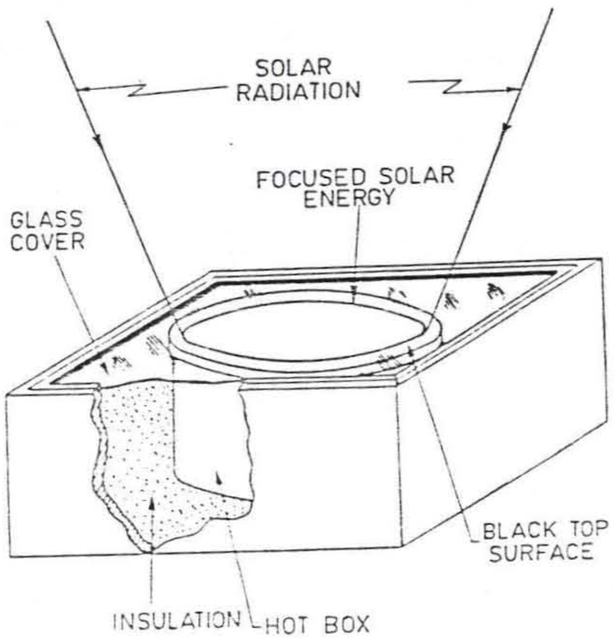
9. Cabinet Solar Dryer



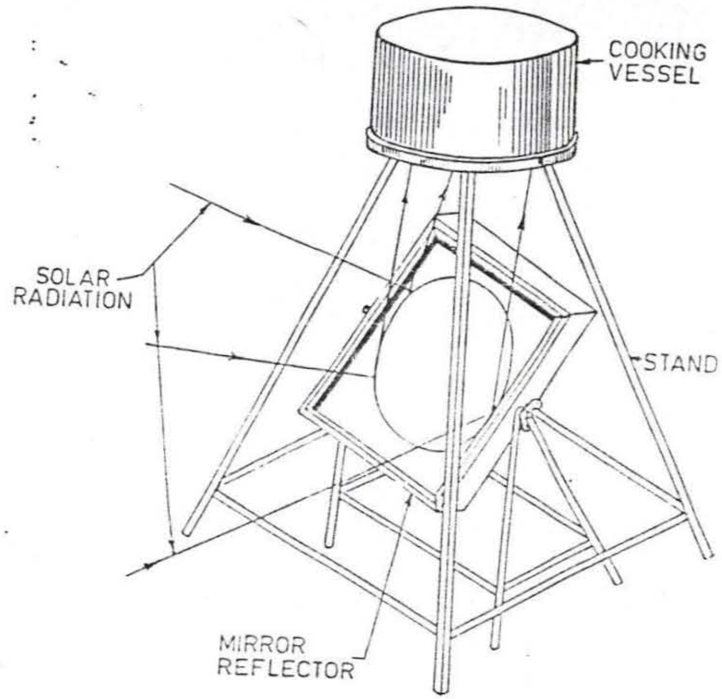
10. Biogas Digester and Stove



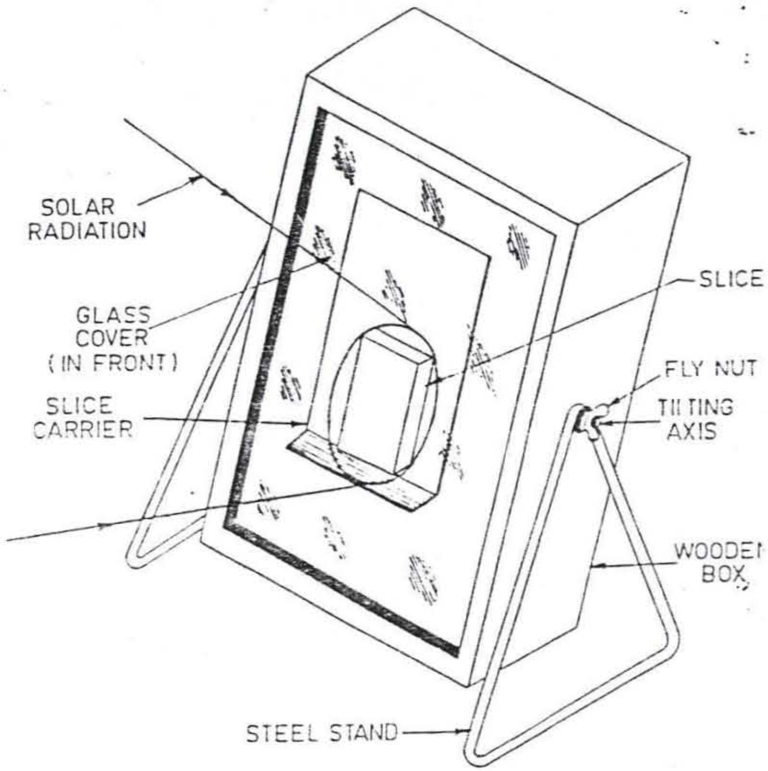
11. $20m^3$ Fixed dome Biogas Digester



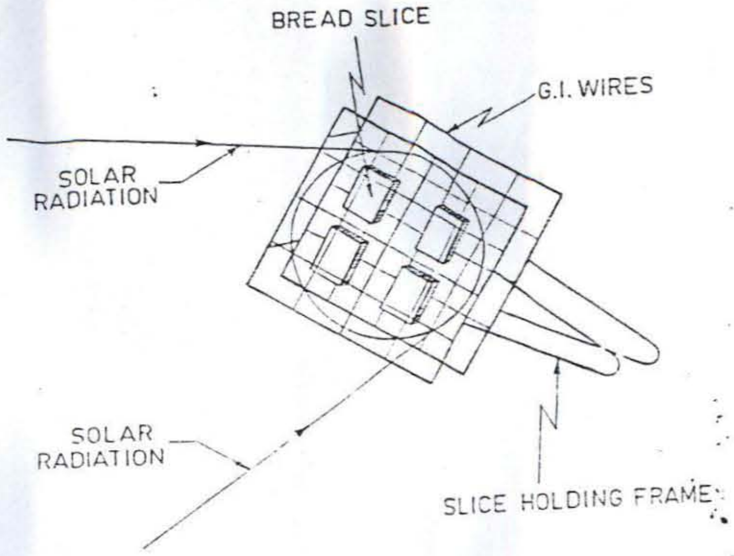
HOT-CASE



COOKING STAND



: SOLAR TOASTER



: MULTI SLICE TOASTER

improve the proper storage of medical facilities in rural clinics and health centers and in the preservation of some agricultural vegetable crops e.g. potatoes, onions, tomatoes etc. vegetables and fruits to reduce spoilage.

2.5.3 Solar egg incubators

Solar energy has potential for the application and hatching of poultry eggs. Gulma. M.A. and Ajikogi S.C. have constructed a typical powered egg hatching machine (incubators from local materials e.g. the solar powered egg hatching machines (incubators) are not yet widely utilized in Nigeria. The application of solar powered egg hatching machine in Nigeria's poultry has a great future.

2.5.4 Green houses

The function of solar green or glass houses is to provide much heat from solar energy required for the growth of plants vegetables etc in cold climate periods.

The glazing of solar green/glass is transparent to ultra violet radiation but opaque to infrared radiation resulting to the trapped solar heat. Nine units of glass house with glass at the sides and glass-roof and five glass houses with glass roof tops and galvanized metal or nylon mesh at the side were constructed at the department of crop protection, institute of agricultural research, A.B.U. the glass roofs and side units are intended to provide the much needed heat to facilitate the healthy growth of plants especially during the cold harmattan period in northern Nigeria when there is less sun shine. Because of the intensive heat generated in them during some parts of the year, humidifiers were introduced to moderate the heat in them. The side-meshed units are least intensive.

Researchers conduct experiments in these glass house units, which are supposed to provide, controlled for these experiments, the outcome of which are transferred to the field for future confirmation of the results. Green house agriculture is not yet widely practiced in Nigeria but has a great promise for application during the cold harmattan period of the years in Northern Nigeria.

2.5.6 Solar photovoltaic applications

Through research and development, researchers at the energy research institutes, universities, polytechnics, and others institutions established in Nigeria have both shown the capability to design and install some PHOTOVOLTAIC (pv) SYSTEMS. Photovoltaic companies have already been installing PV systems in various parts of the country. The main area in which research development and application of photovoltaic have been or are being undertaken in Nigeria will be discussed below.

2.6 SOLAR CELLS DEVELOPMENT IN NIGERIA

The solar cell is a semi conductor diode capable of developing a voltage of 0.5-1v and current of 20-40mA/cm2 depending on the materials used and the conditions of the sunlight. Solar cells comes from the basic components of Pv systems. They convert solar radiation directly into current (DC) electricity, which may either beefed directly to the load or is converted alternative current (ac) by power conditioning circuits before being fed to the loads. The basic theory of solar cells exists in the literature already. In spite of the vast quantity of sand easily available in Nigeria for the manufacture of silicon solar cells, commercial solar cells for application in PV system are not yet being manufactured in the country. Commercial solar cells used in PV systems in Nigeria have imported from foreign countries. The imported PV solar cells have been mainly of amorphorous, polycrystalline and monocrystalline silicon solar cells. The solar cells in modules and panel arrays are first characterized in order to assess their performance in the varying climatic conditions of cloudy, rainy, hammarttan (dusty) and clear days of the years in the local environments before integration into the PV systems.

Power supply as a competitive factor

As far as te ecommunications is concerned, the supply of power tends to rather fade into the background. However, with the pressure of competition increasing all the time, no telecommunications provider can afford to offer its customers an unreliable service. One prerequisite for reliable operation of telecommunications systems is the availability of good power supplies.

In a town with a modern infrastructure this is generally not a problem since there are sources of power everywhere and the only thing that carriers have to worry about is providing suitable backup units to guard against a possible power failure. In remote and inaccessible districts the situation is somewhat different. There is probably no available power supply grid and installing one would be a very expensive business - so that there is a need to fall back on power generated on-site.

Solar-operated GSM-standard mobile communications phone booth

Naran, Pakistan: Solar power supply for repeater station

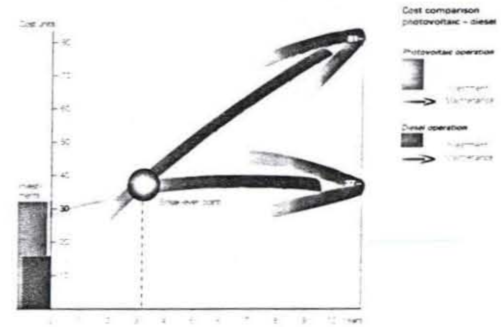
Diesel generators versus solar energy

When it is a matter of supplying power to small loads, diesel generators are too expensive in long-term operation. They are subject to mechanical wear and tear, they need regular refueling and specialized maintenance - and they also need to be replaced after a certain time.

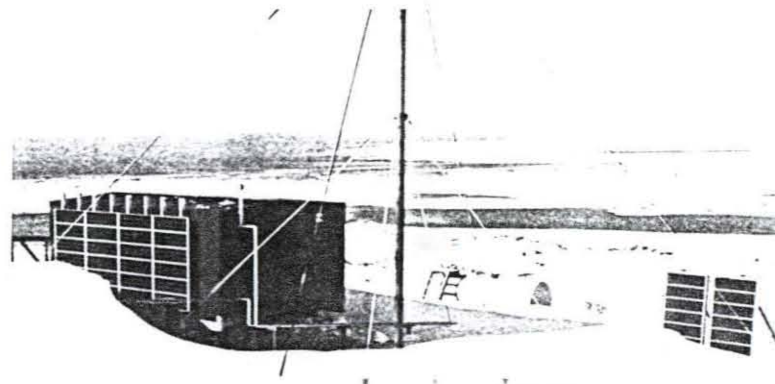
An increasingly attractive alternative is solar energy: Reliability, low maintenance requirements and the demonstrable ability to deliver power in practically any environment make photovoltaics ideally suited to cost effective use in telecommunications systems: Telecommunications equipment ranging from emergency telephones on the highways of North America to radio relay stations in South Africa - with outputs from 0.025 kWh to 25 kWh per day - can be operated cost effectively with solar power.

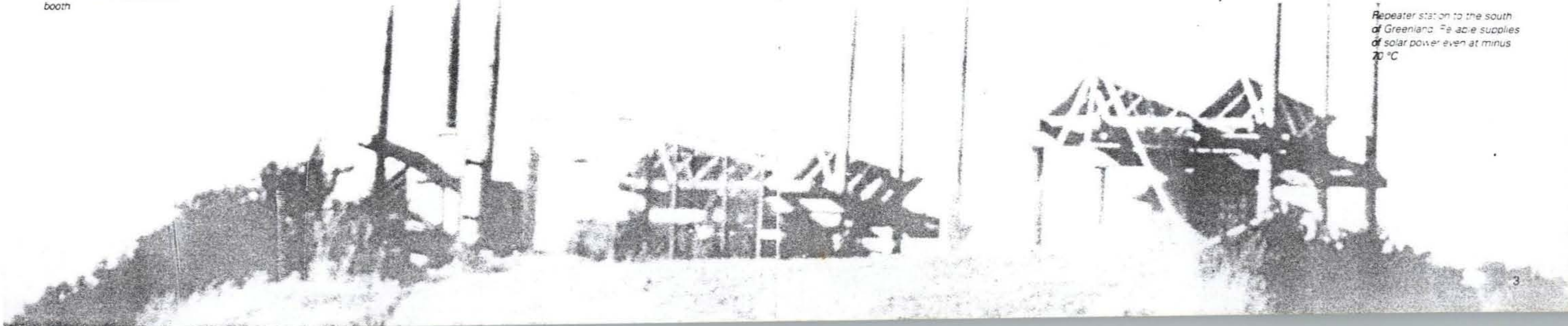
In particular applications, a combined power supply using photovoltaics and diesel can also be a viable alternative. These hybrid systems, which are cost effective in operation for outputs of between 10 kWh and 220 kWh per day, can use the strengths of both energy sources:

- highly secure supply by combining two energy sources
- reduced fuel and maintenance costs compared with a pure diesel system
- increased life for the diesel generator because its use is optimized in normal operation
- better use and flexibility, particularly where the load varies widely
- lower total acquisition costs compared to a pure photovoltaic plant



Each case should be evaluated to see whether a hybrid solution or a pure photovoltaic plant is the right solution for the customer. For example, if it is difficult to reach the site, the logistics costs for fuel and maintenance can quickly mount up to the point where a hybrid solution would no longer be worthwhile.





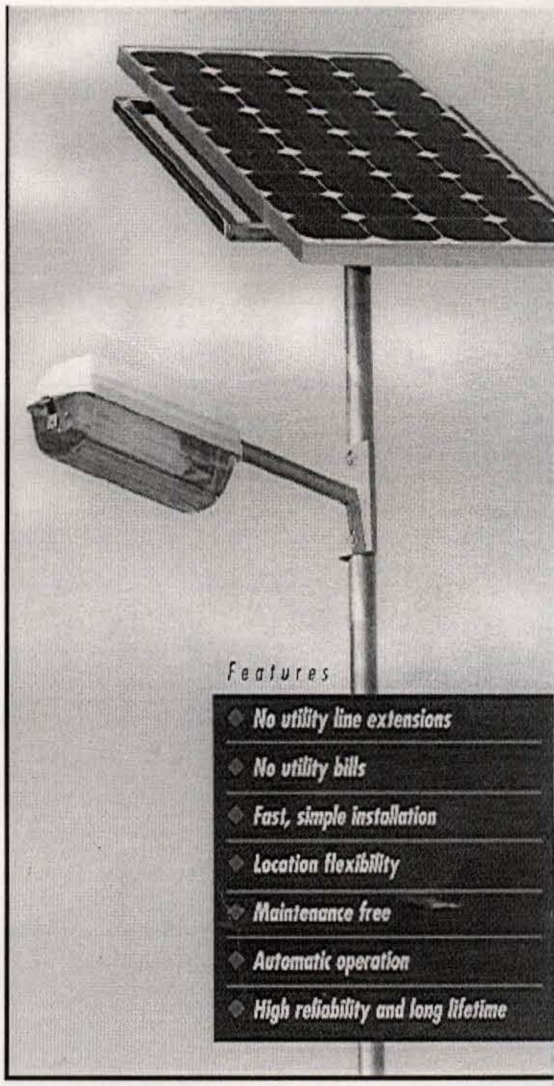
Repeater station to the south of Greenland: Reliable supplies of solar power even at minus 70 °C

SIEMENS

Solar Street Lights

The Siemens Solar range of area and street lighting systems are completely stand alone units requiring no utility line connections and are maintenance-free, making them ideal for locations where utility power is unavailable or uneconomic.

The systems generate their own electricity from the solar modules during the day, which is stored in Deep cycle maintenance free batteries for night time use. Intelligent electronics sense nightfall, and automatically activate the lamp which, via a user settable timer can operate for a pre-set number of hours or until dawn. An internal charge controller protects the battery against over charge and over discharge.



Features:

- **No utility line extensions**
- **No utility bills**
- **Fast, simple installation**
- **Location flexibility**
- **Maintenance free**
- **Automatic operation**
- **High reliability and long lifetime**

Siemens Solar street light systems utilize either compact fluorescent lamps(white light) or high efficiency SOX-E lamps(yellow light). These lamps have very long lamp lifetimes and operate reliably under very harsh weather conditions.

APPLICATIONS

Lighting of streets, markets, squares, car parks, bus stops, rural roads, roundal crossings, footpaths, camp sites, beaches, service stations and many more applicatio

All materials used in the Siemens Solar street light systems construction are completely protected against corrosion and are vandal and theft resistant. Installation of the Siemens Solar street light system is very simple and flexible, with the battery located underground. For specific projects, modified versions of the Siemens Solar street light systems can be provided.

Quality and experience gives top-notch performance

Siemens Solar is the world's leading supplier of solar cells and solar modules - with leading-edge technology, 30 years of experience and customer-oriented solutions in all areas of photovoltaics applications. To date we have delivered solar cells and modules with a peak power output of more than 150 Megawatts - this corresponds to around one fifth of the rated photovoltaic output installed worldwide.

From growing the crystals to the finished solar module every stage of the process is handled by Siemens Solar. This total control over manufacturing guarantees the high quality and longevity of our products. This makes us the only company in the photovoltaics industry in a position to offer our customers a 25-year limited power warranty.

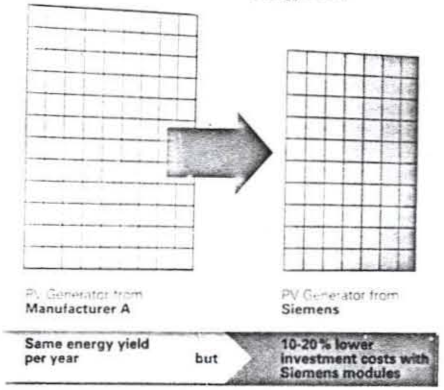
Top-notch technology for the maximum efficiency

With our proprietary Power-Max® technology we optimize the cells and modules for use in real-world conditions. This includes the growing of high-purity, single-crystalline silicon ingots and special processes for optimizing efficiency.

Siemens is the first manufacturer to process silicon wafers under clean-room conditions. Even at relatively low light levels, Siemens Solar cells deliver the maximum possible energy just where other technologies are suffering sharp losses in power output. The multi-stage proprietary TOPS™ (Texture Optimized Pyramidal Surface) process also optimizes absorption of light by the modules. A special textural etching system creates a pyramid-shaped surface on the cell which minimizes dispersion losses. This makes for a particularly high yield even in low light. This means that the cell delivers the maximum energy throughout the day.

Siemens Solar specifies high quality standards in every stage of production which set the benchmark for others. Careful controls guarantee consistently high quality which for many years has been verified by the leading independent testing agencies - including ESTI (Ispra, TÜV, UL and FM).

Solar modules from Siemens are the right choice for a higher level of operating efficiency in practice. They are demonstrably more efficient and cost effective. This is backed up by impartial investigations undertaken by the Fraunhofer Institute for Solar Energy Systems. In comparison with other modules, ours save 10 to 20 % of investment costs with the same energy yield.



Source:
Annual Journal 1996, FhG ISE

- Only Siemens modules achieve the maximum levels of *operational* efficiency.
- Greater efficiency saves around 10 to 20% in investment costs compared to modules from other manufacturers.

Our services fit you like a glove

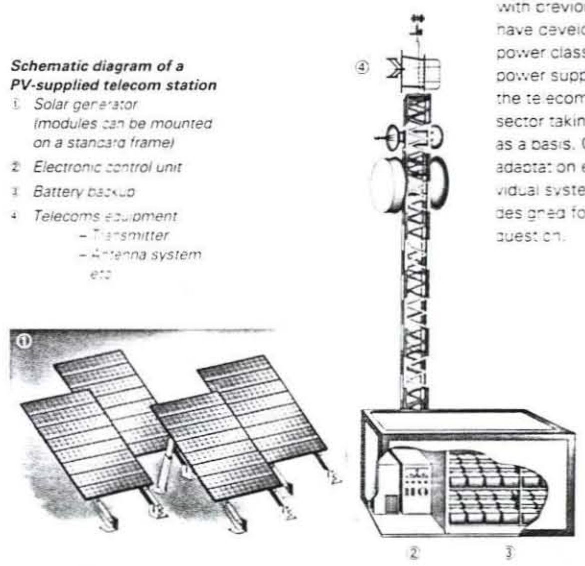
In practice, the different types and sizes of individual projects mean that the rated outputs and requirements to be realized differ widely: from just 10 to far in excess of 10,000 W_p - from a tiny telephone booth to a huge transmitter and receiver station, from the standalone solution through to sprawling networked communication systems.

Siemens Solar offers you individual and expert system consultancy and support for every eventuality: From power supply - solar modules, junction boxes, mounting structures - through to power distribution - charge regulators, batteries, protection and alarm signaling units.

Drawing on our experience with previous projects, we have developed standard power classes for solar power supply systems in the telecommunications sector taking load profiles as a basis. Computer-aided adaptation ensures that individual systems are perfectly designed for the purpose in question.

Schematic diagram of a PV-supplied telecom station

1. *Solar generator (modules can be mounted on a standard frame)*
2. *Electronic control unit*
3. *Battery backup*
4. *Telecoms equipment*
   - *Transmitter*
   - *Antenna system*
   - *etc*



W_p Watt peak = peak power under standard test conditions

Air Mass	AM = 1.5
Insolation	E = 1000 W/m²
Cell temperature	Tc = 25 °C

Listed below are the points that need to be considered during the design phase of a photovoltaic plant:

Application:
Radio relay station, satellite ground station etc.

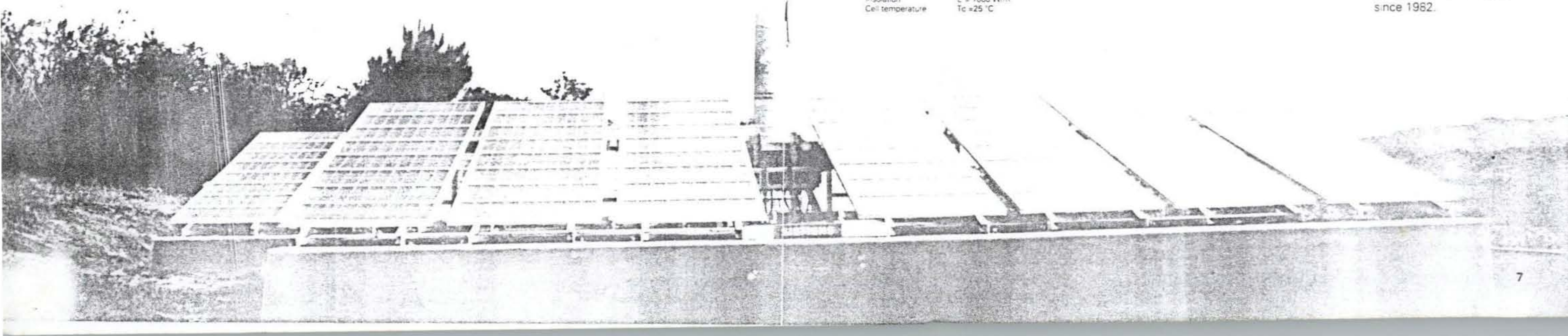
Location:
Geographical data, site description, accessibility (trees or masts can lead to unwanted partial shading of the solar modules. PV components can be easily delivered by truck or as very only possible by helicopter)

System voltage of loads:
12, 24, 48 volts DC or 110, 230 volts AC

Load profile:
Standby and peak power in watts, load variations with time

Other customer system requirements:
Autonomy, battery type, lightning protection

We have the best references:
Pages 10 and 11 show a selection of our major reference sites where our products have been used since 1982.



2.7 SOLAR WATER PUMPS

Solar PV powered water pumps have promise for the provision of sufficient water for irrigation farming human and animal consumption in especially the semi-arid rural areas of the northern state. Research at the polytechnic Birnin Kebbi, SERC, UDU, Sokoto, NCERD, UNN, have designed, installed, tested and characterized a number of solar PV pumps. The performance of these solar PV pumps was found to be satisfactory.

More than 200 solar PV water pumps of capacity 1.5kwp each been installed in various parts of the country the polytechnic.

2.8 SOLAR TECHNOLOGIES

Solar technologies use the sun's energy and light to provide eat, light, hot water, electricity, and even cooling, for homes, businesses, and industry.

Photovoltaic (solar cell) systems convert sunlight directly into electricity. A solar or PV cell consists of semi conducting material that absorbs the sunlight. The solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. PV cells are typically combined into modules that hold about 40 cells. About 10 of these modules are mounted in PV arrays. PV arrays can be used to generate electricity for a single building or, in large numbers, for a power plant.

A power plant can also use a concentrating solar power system, which uses the sun's heat to generate electricity. The sunlight is collected and focused with mirrors to create a high-intensity heat source. This heat source produces steam or mechanical power to run a generator that creates electricity.

Solar water heating systems for buildings have two main parts: a solar collector and a storage tank. Typically, a flat-plate collector a thin, flat, rectangular box with a transparent cover is mounted on the roof, facing the sun. The sun heats an absorber plate in the collector, which, in turn, heats the fluid running through tubes within the collector. To move the heated fluid between the collector and the storage tank, a system either uses a pump or gravity, as water has a tendency to naturally circulate as it is heated. Systems that use fluids other than water in the collector's tubes usually heat the water by passing it through a coil of tubing in the tank.

Many large commercial buildings can use solar collectors to provide more than just hot water. Solar process heating systems can be used to heat these buildings. A solar ventilation system can be used in cold climates to preheat air as it enters a building. And the heat from a solar collector can even be used to provide energy for cooling a building.

A solar collector is not always needed when using sunlight to heat a building. Some buildings can be designed for passive solar heating. These buildings usually have large, south-facing windows. Materials that absorb and store the sun's heat can be built into the sunlit floors and walls. The floors and walls will then heat up during the day and slowly release heat at night, a process called direct gain. Many of the passive solar heating design features also provide day lighting. Day lighting is simply the use of natural sunlight lighten up a building's interior.

2.9 SOLAR TECHNOLOGIES PHOTOVOLTAICS(PV)

Photovoltaic solar cells, which directly convert sunlight into electricity, are made of semi conducting materials. The simplest cells power watches and calculators and the like, while more complex systems can power

houses and provide power to the electric grid.

2.10 PASSIVE SOLAR COOLING HEATING AND DAY LIGHTING

Buildings designed for passive solar and day lighting incorporate design features such as large south-facing windows and building materials that absorb and slowly release the sun's heat. No mechanical means are employed in passive solar heating. Incorporating passive solar designs can reduce heating bills as much as 50 percent. Passive solar designs can also include natural ventilation for cooling.

2.11 CONCENTRATING SOLAR POWER

Concentrating solar power technologies use reflective materials such as mirrors to concentrate the sun's energy. This concentrated heat energy is then converted into electricity.

2.12 SOLAR HOT WATER AND SPACE HEATING AND COOLING

Solar hot water heaters use the sun to heat either water or a heat-transfer fluid in collectors. A typical system will reduce the need for conventional water heating by about two-thirds. High-temperature solar water heaters can provide energy-efficient hot water and hot water heat for large commercial and industrial facilities.

2.13 SOLAR RESOURCES

Solar resource information provides data on how much solar energy is available to a collector and how it might vary from month to month, year to year, and location to location. Collecting this information requires a national network of solar radiation monitoring sites.

CHAPTER THREE

3.0 NATURAL VENTILATION

3.1 INTRODUCTION

Strictly defined, the term natural ventilation applies only to those processes of heat dissipation that will occur naturally, that is without the mediation of mechanical components or energy inputs. The definition encompasses situation where the coupling of spaces and building elements to ambient heat sinks (air, sky, earth, water) by means of natural modes of heat transfer leads to an appreciable cooling effect indoors.

However, before taking measures to dissipate heat, it is prudent to consider how the build-up of unwanted heat can be prevented or limited in the first place. In this context we have chosen to consider natural cooling in a some what wider sense the and the strict definition above suggests, to include preventive measures for controlling cooling loads as well as the possibility of mechanical assisted heat transfer to enhance the natural process of ventilation.

As with the design of passive solar building where heating is the main concern, the implementation of passive cooling techniques is a multi-layered process inextricably linked with the architectural design of the building in its environment and the anticipated patterns of use. The processes involved in ventilation are fundamental linked to those of the climate and the earth's daily energy exchange. Similarly, the body's comfort tolerance will influence the choice of cooling techniques used in different circumstances.

Modification of the microclimate around a building can help to improve comfort condition in and around the building, while reducing cooling loads. This can be achieved by lowering outdoor temperatures through solar protection; wind channeling, evapo-transpiration of plants and the evaporation of water. There are many opinions available to the designer for ventilating domestic and non-domestic buildings, which can help to avoid the use of mechanical air conditioning while achieving comparable comfort levels with much lower energy use and consequent saving in atmospheric pollution.

A useful strategy for the overheating season is to first control the amount of heated air reaching the building, then to minimize the effect of unwanted solar heat within the building skin or at openings, next to reduce internal or casual heat gains from appliance and occupants and finally where necessary to use environmental heat sinks to absorb any remaining unwanted heat. Example of the later includes natural ventilation, ground cooling, evaporative cooling and radioactive cooling. This chapter is structured accordingly, although in practice a combination of these cooling techniques is almost invariably in operation.

3.2 SOLAR CONTROL

Direct solar radiation can be prevented from reaching all or part of the walls, roof or windows of a building by the use of shading. Natural vegetation, neighbouring buildings or the surrounding landscape can provide shading.

3.3 THERMAL INERTIA

The thermal inertia of the building fabric may be used to reduce heat flow to the interior of the building this is especially useful where heavyweight construction is used, as is usually the case in Europe. Materials with a high heat storage capacity, such as concrete and brick, heat up and cool down relative slowly. When a solar radiation strike an opaque or solid radiation strikes an opaque or sold surfaces such as a wall or roof the exterior surface absorb part of the radiation and converts it to heat. Part of the heat is directly re-emitted to the outside. The reminder is conducted through the wall or roof at a rate, which depends on the thermal diffusion characteristics of the materials. When the temperature of the exterior surface drops due to a fall in ambient temperature, part of the stored heat is emitted outside.

At night, the air temperature inside the building is usually higher than temperature outside. The heat flow is therefore to the outside and the temperature of the wall or roof continues to decrease, thus, eventually cooling the interior. The contribution of thermal inertia to natural ventilation is particularly useful where there are significant daily variations in external temperatures – in hot, dry climates, for instance.

3.4 THERMAL INSULATION

Thermal insulation may combine two physical processes reducing thermal transmittance of the envelope and maximizing long wave radiation usually only the first principle is taken into account incorporated in the concept of radiant barriers in a multiplayer element, a low. Both these processes can be emissive materials (such as an aluminum foil) next to an air gap will impede radiation, thus reducing the temperature of the of the internal walls and also room radiant temperature. At night, foil will block radiant exchange, reducing night cooling reduction in cooling load of some 10% been reported.

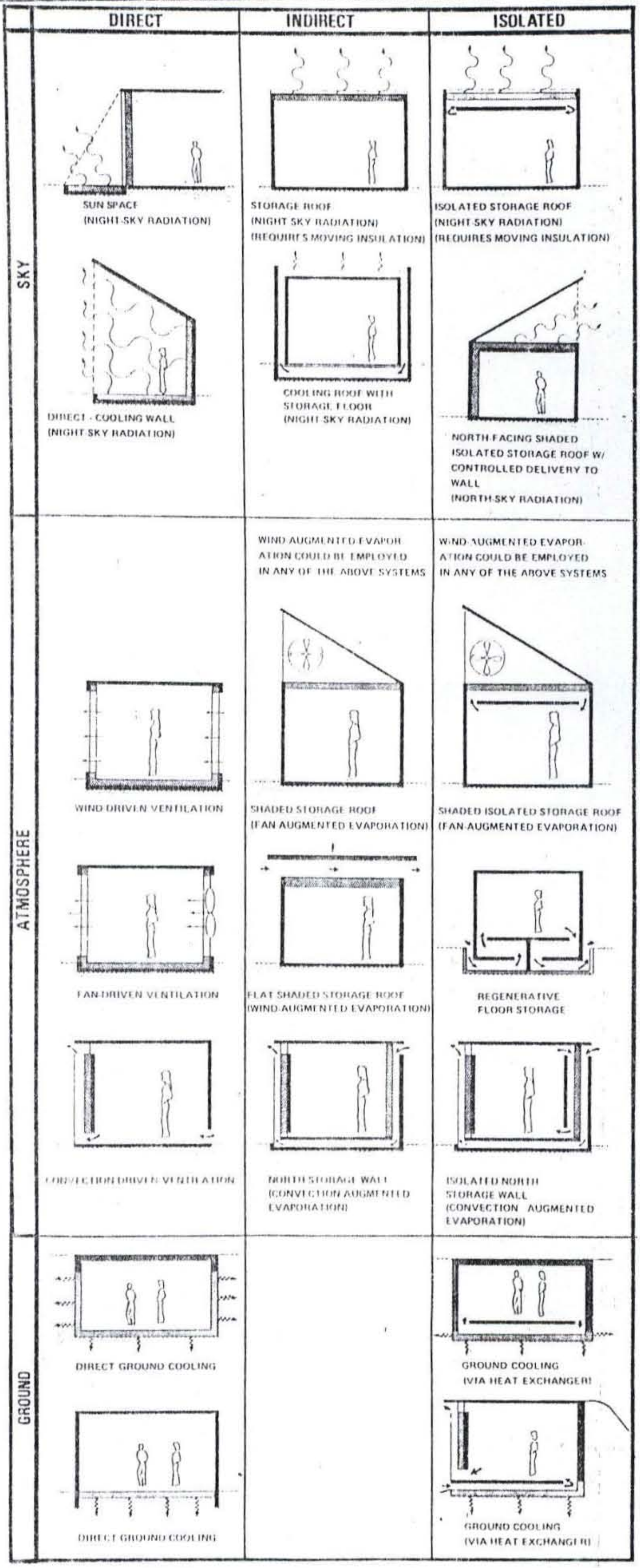
3.5 THERMAL MASS

Floors, internal walls, roofs partitions, and furniture, can provide thermal storage capacity, usually referred to as thermal mass. Thermal mass may have a significant effect on mass may have a significant effect on comfort, energy consumption and peak cooling load. It can store both heat and "cloth" and if well designed and positioned, can act as a regulator, smoothing temperature swings, delaying peak temperature, decreasing mean radiant temperature and providing improved comfort conditions. The need for appropriate –sized and placed thermal mass should be a major consideration in the design of the structure. Thermal mass moderates temperature swing by absorbing heat directly from sun patches or from the air. The stored heat can be dissipated in the evening or at night, via natural ventilation cooling in some cases, the stored heat provided useful wrath in the early morning. The key issue is to maximize the convective heat transfer between the thermal mass and the air unfortunately; this parameter is usually accounted for by an empirical value. This difficult becomes critical when we have to deal with a dual dry/wet seasons. Another difficulty is due to the thermal inertia of the mass compared to the relative fast processes at the boundary layers. For optimum design, thermal mass should be considered in conjunction with the heating and cooling controls to be used.

The role of thermal mass is particularly important for condition of continuous building occupation. Shaviv's numerical approach has given some recommendation for buildings.

3.6 AIRTIGHTNESS

Design for cold conditions trends to promote airtightness in the buildings, and this is entirely compatible with the requirement for hot weather. In the summer, when the outside air temperature, any air infiltration will represent a cooling loads for the building.



Examples of passive cooling systems [4].

3.7 ENVIRONMENTAL HEAT SINKS

If the methods of avoiding unwanted solar or casual heat gains have been applied and temperature within the building are steel predicted to be a times too high then the surrounding air and ground can often used to provide ventilation.

3.8 VENTILATION

Natural ventilation can be produce a significant effect depending on the configuration of the building on the site and the surrounding spaces, the direction and strength of wind flow and the time of day. The layout of internal spaces in plan and section according to function is important particularly for air movement indoors and the potential for cross ventilation. To be effective ventilation air should be cooler than internal air but air movement passed an object also creates a chilling effect. Ventilation air pass through tunnels or pipes below ground can be appreciable cooler than the air surrounding bu9odings.

Ventilation provides cooling by using air to carry heat away from the building and from the human body. Air movement may be induced either by natural forces (wind and stack effect) or mechanical power. Airflow pattern are the result of differences in the pressure distribution around and within the building.

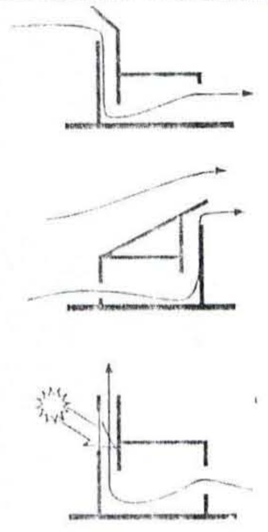


Figure 6.9. Ventilation using wind towers and a solar chimney [1].

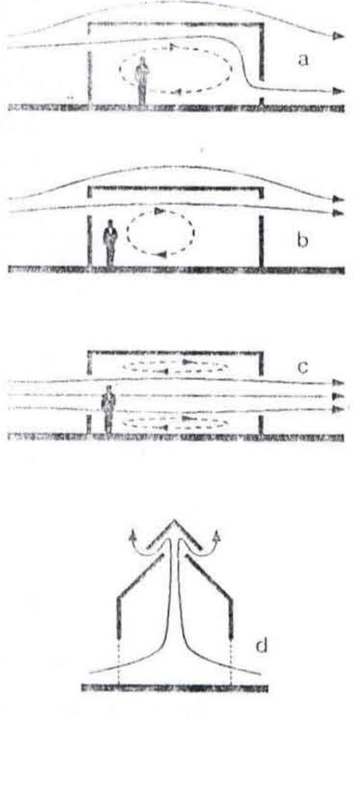


Figure 6.12 a-d High inlets do not generate a strong air velocity in the occupied zone and are thus less suitable for occupant cooling. However, this configuration is often interesting for night ventilation because the air stream may be directed toward the storage element, for example a massive ceiling. Moreover, the high position offers better security against intruders. Openings at body height generally offer good cross ventilation.When the building is too deep to offer cross ventilation, or when opposing openings are not possible, roof openings may be used to encourage an anabatic flow. The roof opening should be designed to create a low pressure region next to the opening to enhance the natural stack effect.

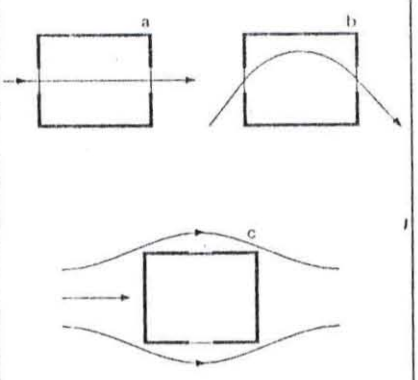


Figure 6.10 a-c When inlet and outlet are aligned with the wind, the air flow is short-circuited and poor secondary flow is generated next to the main stream.
If the wind is oblique to the openings, the air flow circulates in the entire building.
If the wind is parallel to the opening, no significant movement occurs within the occupied space.

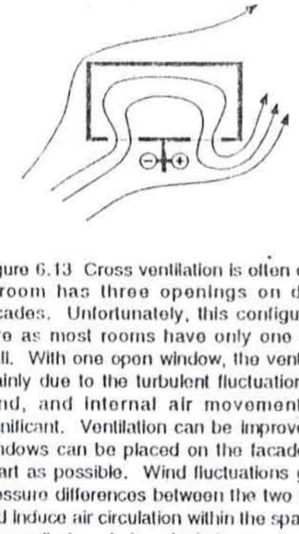


Figure 6.13 Cross ventilation is often optimal if a room has three openings on different facades. Unfortunately, this configuration is rare as most rooms have only one external wall. With one open window, the ventilation is mainly due to the turbulent fluctuations of the wind, and internal air movement is not significant. Ventilation can be improved if two windows can be placed on the facade, as far apart as possible. Wind fluctuations generate pressure differences between the two windows and induce air circulation within the space.
Wingwalls for windward windows can enhance the pressure differences between two windows and induce air circulation within the space. Wingwalls for windward windows considerably increase cross ventilation in the room. Unfortunately, they are ineffective for leeward facades.

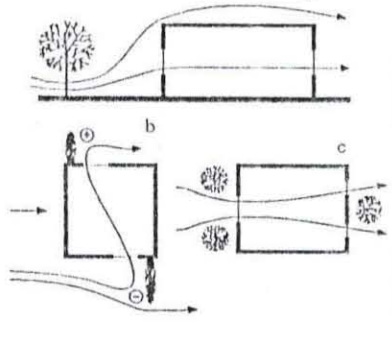


Figure 6.15 Influence of vegitation on airflows, also providing air filtration, noise reduction and shading

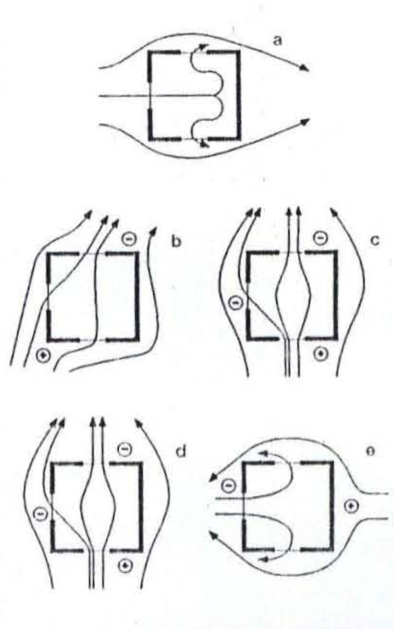


Figure 6.11 a-e Cross ventilation can be further enhanced by placing two outlets on the building sidewalls. This design option also addresses the frequent shifts in wind direction.
The distribution of the openings on the building facade is a key issue for efficient natural ventilation. Ventilation is a three dimensional function and correct location of openings including windows is essential. The position of the inlet dominates the air flow pattern within the space. The position of the outlet is of secondary importance.

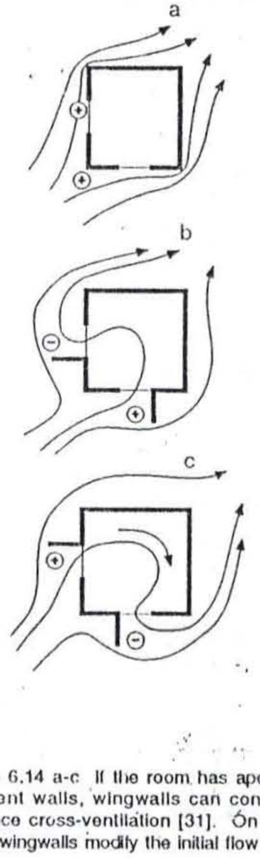


Figure 6.14 a-c If the room has apertures on adjacent walls, wingwalls can considerably enhance cross-ventilation [31]. On the other hand, wingwalls modify the initial flow within the space.
Vegetation can affect the air flow pattern in the same ways as neighbouring buildings or wingwalls [32]. Moreover, it also offer air filtering, noise reduction and shading

Air moves from high-pressure regions to low pressure ones. When the outside air temperature is lower than the inside air temperature, building ventilation may exhaust internal heat gains or solar gains during the day and may flush the building with cool air during the night if required. Indoor air movement enhances the convective exchange at the skin surface and increases the rate of evaporation of moisture from the skin. Evaporation is a very powerful cooling device, which may bring a felling of comfort to occupants under hot conditions.

However, in order to be effective, the surrounding air should not be too humid (relative humidity less than 85%), both the design of the building itself and its surrounding spaces can have a major impact on the effectiveness of natural cooling.

Hourly air changes rates may vary considerably, depending on the circumstances. For ventilation cooling in domestic or office situations, ASHRE standards recommend a maximum of 0.75 to 1 ACH, whereas in densely occupied theatres or bars, the quantity of air passing through an opening can be expressed as:

Q = Cv AV

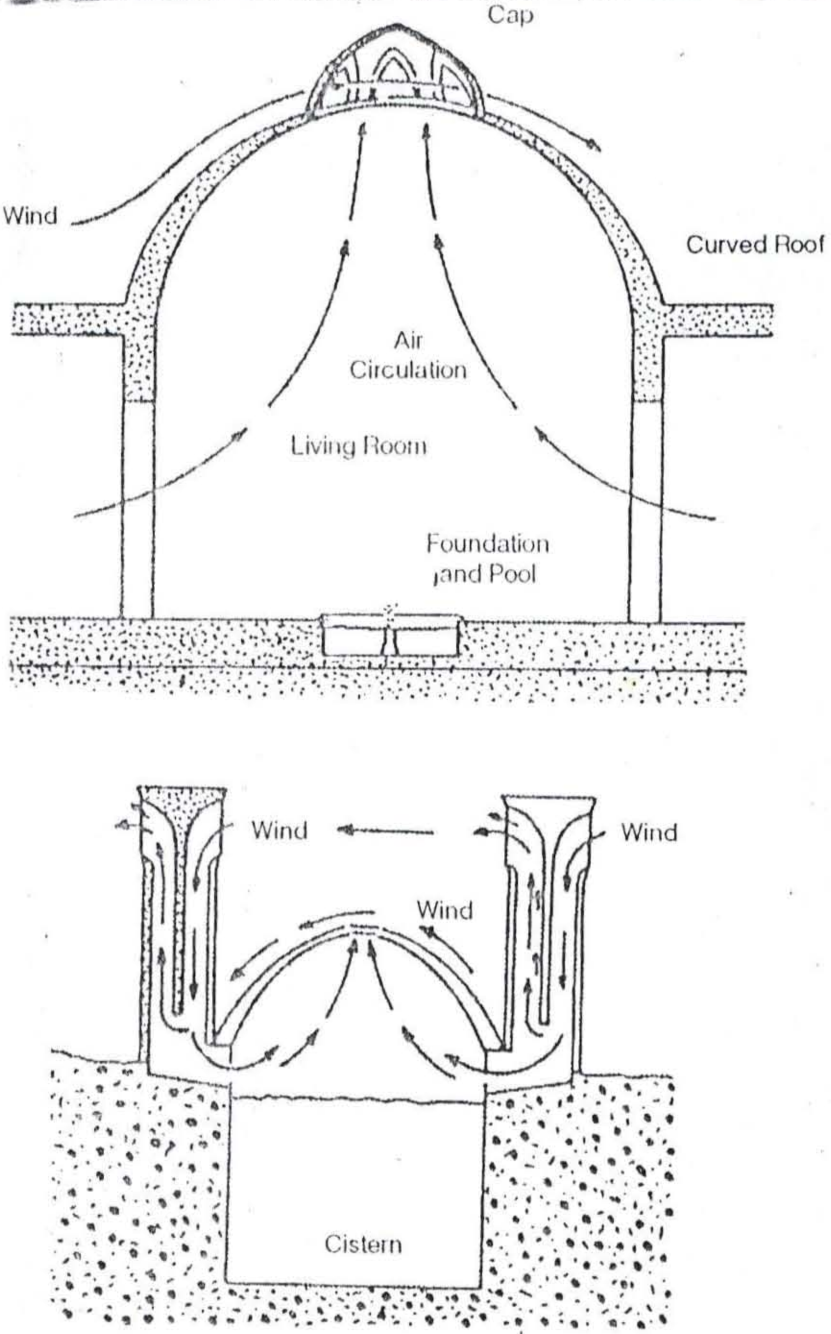
Where

Q = airflow (m3/sec)

A = area of opening (m2)

V = wind velocity (m/sec)

Cv = opening effectiveness



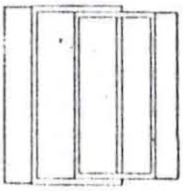
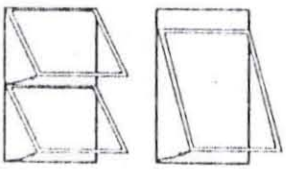
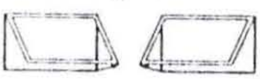
Vernacular examples using airflow over water.

The rate of airflow through the building will be affected by the location, sizing and flow characteristics of openings, the effects of indoor obstacle on air movement and the effect of the external shape of the building in relation to wind direction, for example wing wall walls. Airflow through buildings should be considered in three dimensions. For the forces of buoyancy to act, three must be a significant temperature gradient between the internal and external air, the total airflow. The total airflow normally results from a combination of buoyancy and wind pressure differences, and is affected by the size and location of openings. The design of window systems for ventilation should also take account of daylight, solar gain, security and acoustic considerations.

3.9 VENTILATION STRATEGIES

3.9.1 Wind Towers

Wind towers draw upon the force of the wind to generate air movement within the building. There are various systems based on this principle. The wind-scoop inlets of the tower oriented towards the windward side capture the wind and drive the air down the chimney. The air exists through a leeward opening of the building. The airflow is enhanced by cold night air.

WINDOW TYPE	ADVANTAGES	DISADVANTAGES
Single vertical sliding sash 	Adjustment of the opening area is possible. Air enters the openings and continues inside in the same direction	Opening limited to 50% of the window size. Winter leakage if not properly sealed.
Double vertical sliding sash 	Adjustment of the opening area is possible. Some adjustment of the sashes is possible to direct air streams to a specific area.	Opening limited to 50% of the window size. Winter leakage if not properly sealed.
Horizontal sliding sash 	Adjustment of the opening area is possible to direct air streams to a specific area.	Opening limited to 50% of the window size. Width/height does not favour height afficiency for every wind direction.
Side hung 	100% openable. Sash can act as a wingwall and redirect the flow. Good sealing.	
Top hung 	Excellent protection against rain, whilr permitting some ventilation.	At low opening angles, the air flow is deflected upward, outside the occupied zone of the room. Reduced opening area.
Jalouise 	Can benefit from all wind directions. Almost 100% openable. Can direct the flow.	Difficult to seal when closed.
Bottom Hung 	Good for night ventilation.	Rain penetration. Reduced opening area.

1. Advantages and disadvantages of common window types.

3.92 Ground Cooling

Increasing the building contact with the ground can provide additional cooling throughout the year temperatures below the surface are more constant than air temperatures varying negligibly several metres deep where they are significantly cooler than surface or air temperature summer. The ground can therefore be considered as an almost infinite heat sink, examples are earth sheltered building (built partially underground) and the use of berms or built up earth in contact with perimeter wall. This techniques needs to e considered carefully avoiding problems especially in cold season including damp penetration, condensation, and insufficient daylight.

3.10 DESIGN OF OPENING

The balance between heating, cooling and day lighting is a critical consideration for the choice f orientation and size of opening. The design of opening may usually depend the building type and may be influenced by building regulation particularly with the regards maximum or minimum size for glazed areas. The use additional l device such as overhang and shutters may allow the designer some scope to correct or limit unfavorable orientations or large glazed areas

.

The building envelope design strategies must encompass cold and dry season so that for example excessive solar gains in the dry season can be controlled while adequate daylight is available through the year, thus avoiding the need for artificial lighting during the day and the consequent cooling loads. The sizing of not facing opening is less affected by seasonal variations and may be determined largely by day lighting and cross ventilation requirement. Not facing opening can provide an almost uniform day light source. Effective cross ventilations typically requires large openings distributed across opposing façade, with minimal internal barriers to impede the air flows need for cooling. For single sided ventilation the shape of the opening becomes important, horizontal format been more efficient in stimulating internal air velocities. The design of opening should be undertaken in conjunction with the overall solar control strategy.

3.11 PASSIVE COOLING

To use energy consuming techniques to prevent the accumulation of heat gains above required comfort conditions appropriate to the needs of the space.the following are methods of achieving it.

1. Minimize the ingress of solar radiation by provision of adjustable , external shading particularly to windows facing west and to a lesser extent, to the east.
2. Minimize internal heat gains from artificial lighting by optimizing the availability of day lighting. Separate those are requiring high artificial lighting levels either due to special requirements or because they are used largely outside of daylight hours.
3. Minimize internal heat gains by using low energy equipment or where this is not possible, locate equipment in separate area

with high ventilation rates, ideally down-stream ventilation path through the building.

4. Minimize heat gains from occupants by reducing the occupation density

CHAPTER FOUR

4.0 CASE STUDIES

4.1 CRITERIA FOR CASE STUDIES SELECTION

The case studies in relation to this project were adopted so as to have a focus on the basic design principle guiding a particular case study. It functionality as it relates to different unit within a whole and to the environment; the historical background, the revision behind the set up and its viability, its merit and demerit and its architectural significance toward meeting cultural, artistic, social and economic needs of the people. This project is aimed towards the realization of the design in relation to its climate.

4.2 GENERAL INFORMATION OF CASE STUDIES TAKEN

The objective of carrying out this case studies include;

1) To evaluate the users requirement of facilities provided in the existing spaces and the relationship between them as well as in relation to the required space standards.
2) To evaluate the standard and functional performance of the facilities provided.
3) To evaluate its viability
4) To familiarize one self and the basic design requirement for each separate study undertaken.

5) To improve on the already exiting development in regards to functionality, stability and aesthetics.

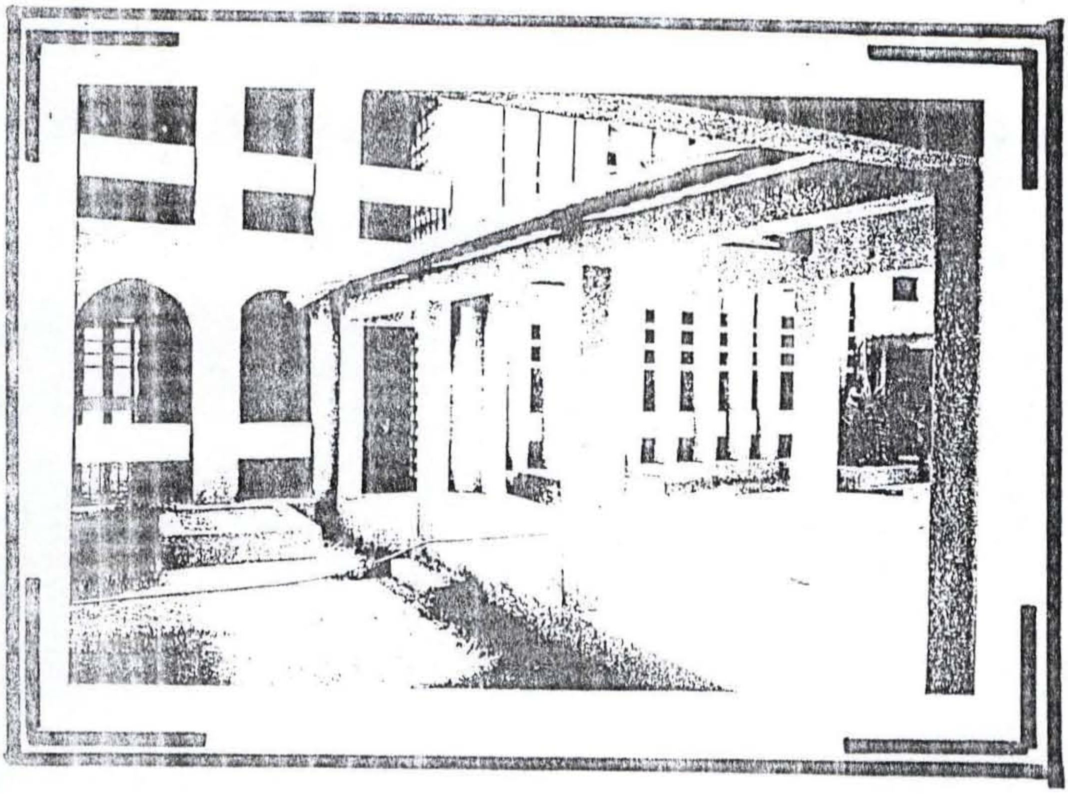
4.3 INTRODUCTION

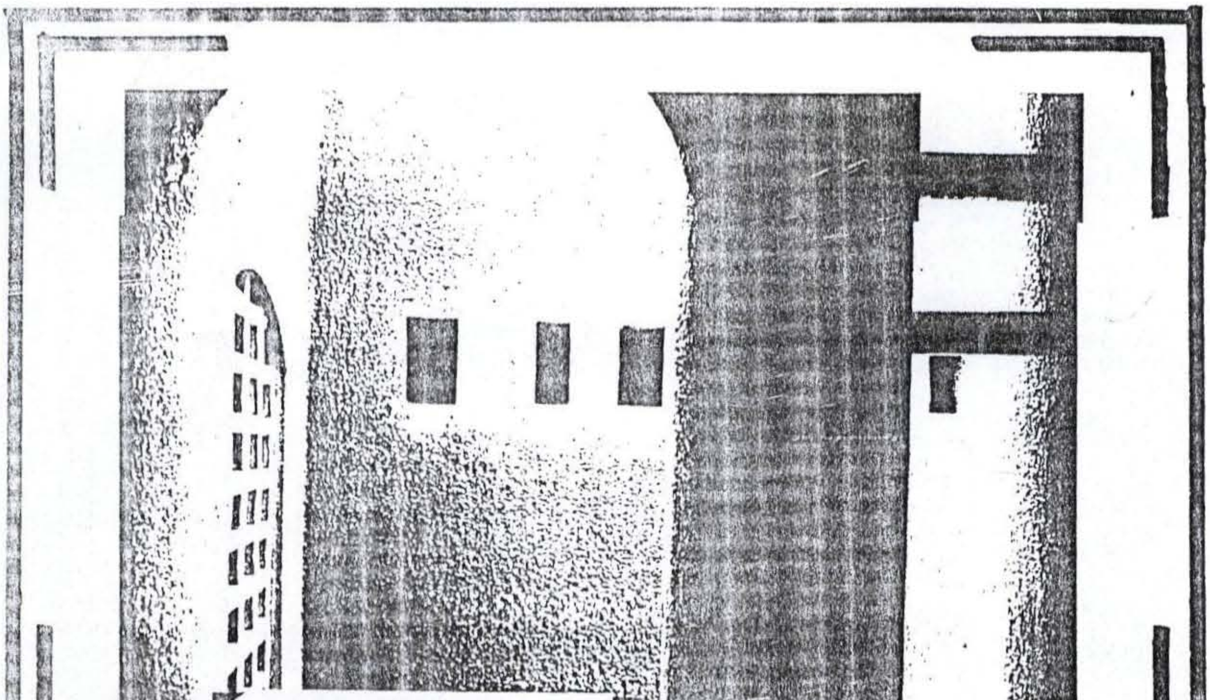
During the process of research and data collection, a research is suppose to study existing similar situation of sub structure. It is also expected that after study one would be able to arrive at a logical conclusion, which no doubt assist in the design approach.

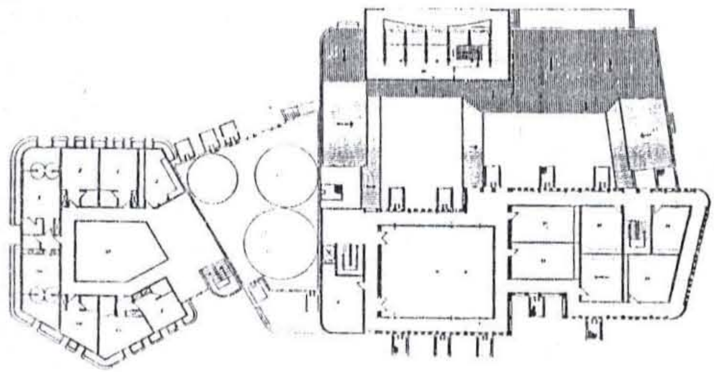
Specific case studies were taken, especially those that were relevant to the study area. Two were local case study and one a foreign case study. The local case studies were visited while the foreign case study was conducted by consulting secondary source of information and literature research.

Case conducted includes: -

i. Solar Energy Research Centre, Sokoto.
ii. Onersol, Solar Energy Research Centre, Niamey, Niger.
iii. Solar Energy Research Centre, Enugu.

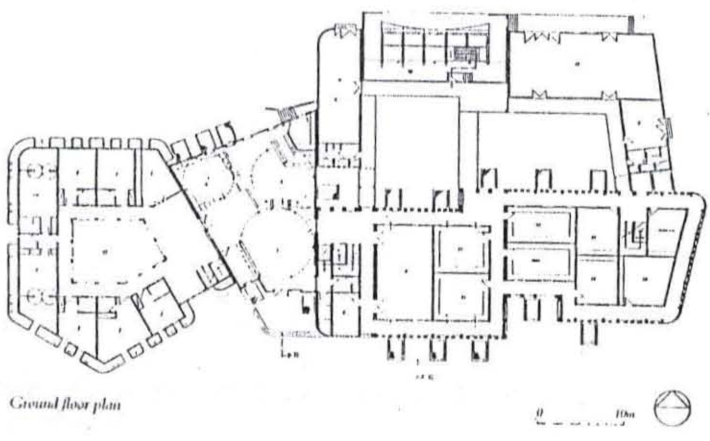






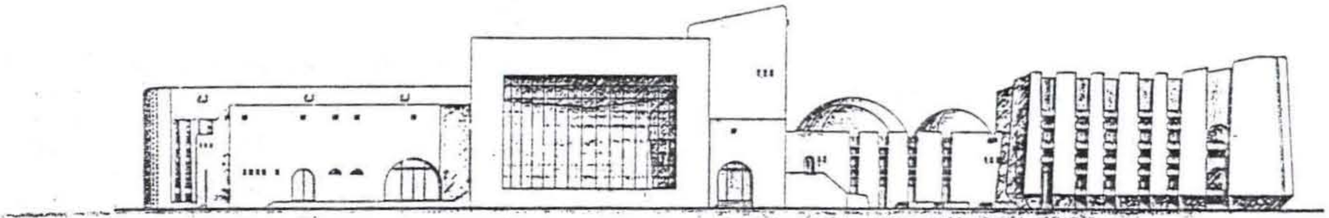
First floor plan

Key
1. Laundry room
2. Bedroom
3. Lounge
4. Cafeterian
5. Entrance hall
6. Workshop
7. W.C., male
8. Equipment room
9. Conference room
10. Solar mirror
11. Laboratory
12. Workshop
13. W.C., female
14. Office
15. Hall
16. Library
17. Patio

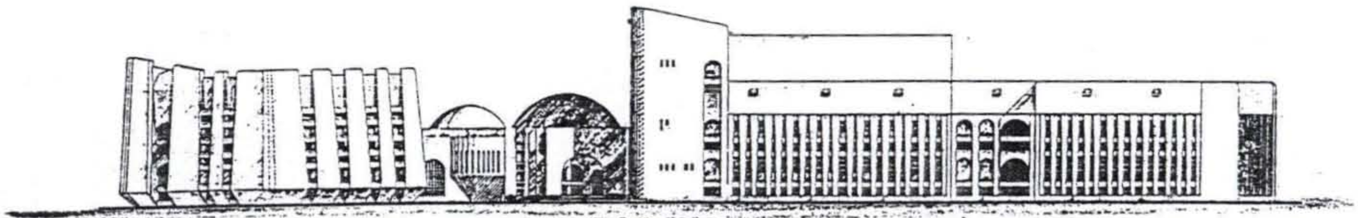


Ground floor plan

Right, above: Interior courtyard.
Right: Covered passageway linking north and south wings of the main building.



North elevation



South elevation

4.3 ONERSOL SOLAR ENERGY RESEARCH CENTRE, NIAMEY

4.3.1 Background Information

The onersol complex, designed by a French Architect, Laszlo Lester Parajd is doubly significant in that it is intended to serve the objective of solar energy programme through project conception and experimentation towards practical application, but it is also a physical structure inspired by traditional local architecture and building materials. Thus, it was from the unset designed as a model of self-reliance in terms of style, materials, and energy consciousness.

The brief for the Onersol building contain research and development activities such as laboratories, administrative offices and documentation, as well as residential accommodation for temporary staff.

4.3.2 Design/ Planning Concept

The French Architect created a building with four distinct parts joined by communication internal courtyards with peripheral galleries; entry for the public is through the central single storey block containing reception lounge and cafeteria; each of this adjourning spaces are covered with a dome, carried on columns, which demarcate the different areas. To the west of the entry is a two storey residential block containing 15 bedrooms with bathroom and organized around a courtyard.

Laboratories, offices, library and meeting rooms are located in another two-storey wing to the south east of the entrance. These spaces are situated at the center of the wing with hallways and galleries around them for protection against the sun. Natural cross ventilation is provided through this into an enclosed courtyard, which separates this wing from the technical workshop and solar mirror in the northern, most section of the building. The complex covers 3500sqm[2.]

4.3.3 Materials And Finishes

The main strategy was to employ traditional and local labour, combing these with modern technology and expertise where necessary. The structure relies whenever with possible upon load bearing walls of mud bricks, stabilized with cements, however, concrete is employed for the foundations, metal trusses of local fabrication and other tension element else where as well as aluminum for the roofing. Exterior are covered cement plaster tinted by pigments found locally.

4.3.4 Circulation And Services

Apart from the choice of low-rise building containing functions arranged around inner courtyards, in keeping the local customs and methods of climate control, there is an interesting architectural feature on the west wall of the residential block. The structural bearing wall have hollow, chimney like element for circulation of air. A continuous airflow through these helps to keep the interior cool, while spacing and thickness on the exterior façade provide protection for windows openings.

Although the building was designed with incorporation of a mechanical air-cooling system run on solar energy, this system was not yet functioning as of May 1983. Effort at the Onersol centre had been concentrated upon the development and production of prototype solar captors, water heaters, distillers, motor pumps and one electro solar power generator located in the centre of Niger.

4.3.5 Observation

A) Merits

i. Simple forms with element of monumental and aesthetically elevations

ii. The clear definition of the complex deserves some applause. Creating separation pf all the functional wings.

iii. The ingress and egress have been designed to facilitate some socio-cultural interaction.

iv. Employment of local building materials and finishes, as a model of self-reliance in terms of style, materials and energy consciousness.

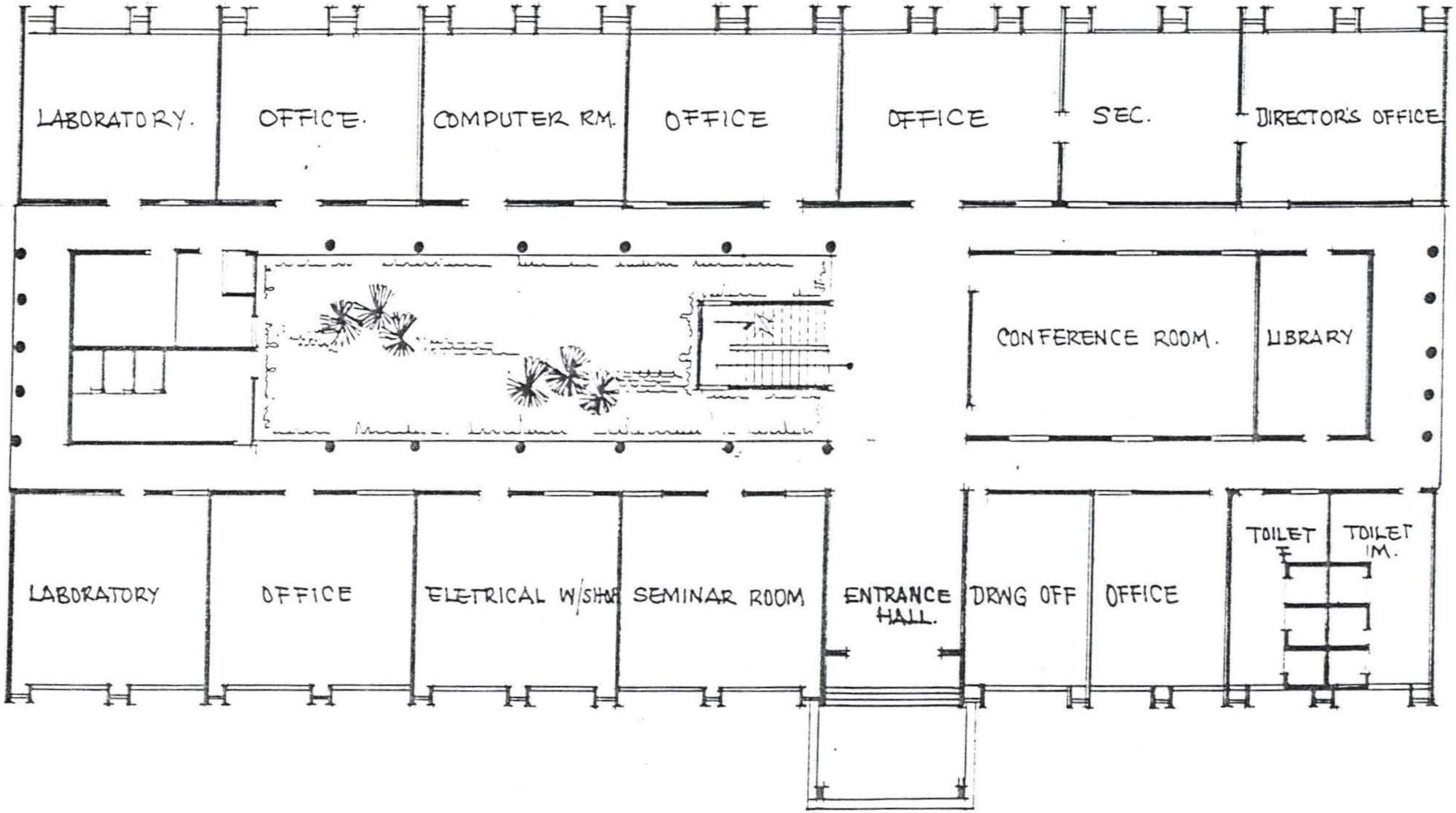
B) Demerit

i. The composition is void of site landscaping.
ii. Inability to define a functional parking space for effective vehicular circulation around the centre.
iii. Inadequate office space for the growing development of the centre.

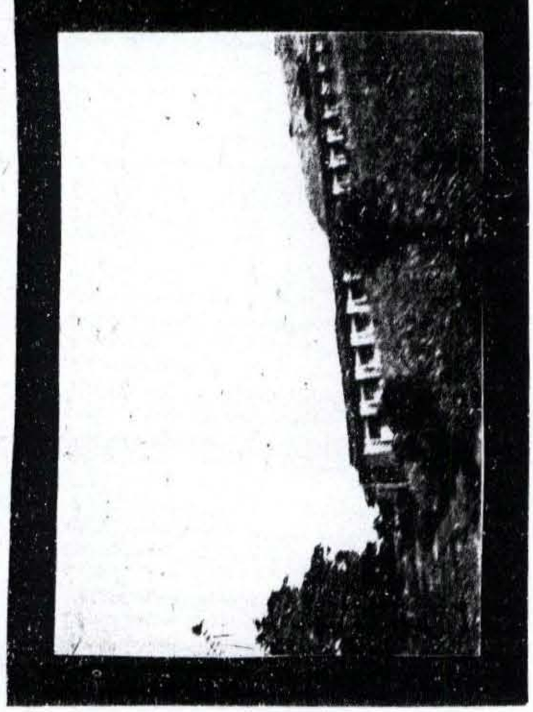
4.4 SOLAR ENERGY RESEARCH CENTRE, ENUGU

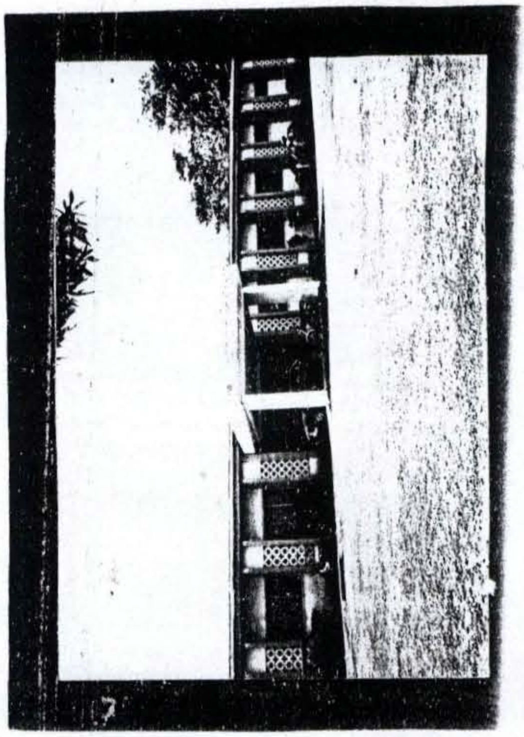
4.4.1 Background Information

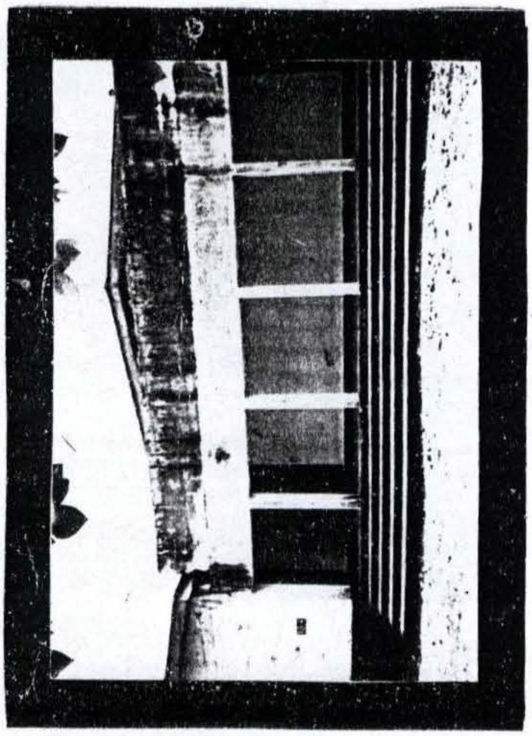
The activities of the energy solar energy Centre focuses on renewable energy and covers research and development, public enlightenment and information dissemination as well as manpower training. Considerable progress in research and development in the field of renewable energy have been obtained the last few years have also witnessed the execution of pilot demonstration project of renewable energy systems, which have direct bearing to the lives of Nigerians.

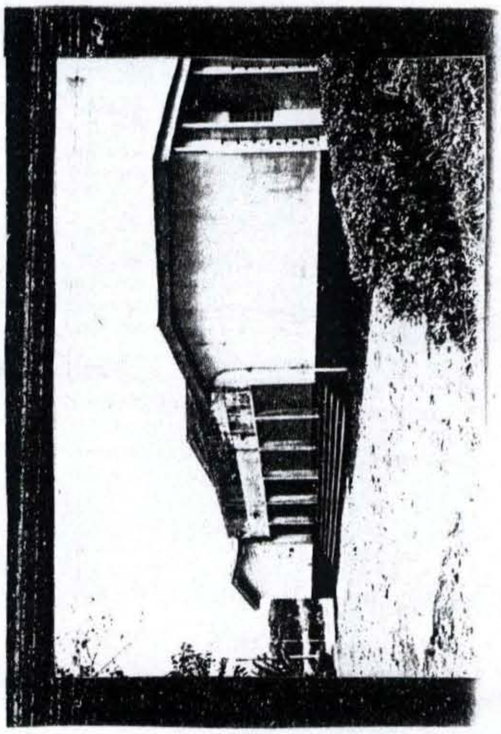


PLAN, ENUGU SOLAR ENERGY RESEARCH CENTRE.









4.4.2 Design/Planning Concept

The centre is a temporary site to house the activities of the energy research, which is a unit part of the University of Nigeria's structure (complex).

Currently, the temporary site of the centre has the following:-

i. A single rectangular structure housing offices rooms for administrative and research personnel, a common room, computer room, general office, laboratories electrical/ mechanical workshop, library and conference rooms.
ii. A fenced testing and demonstration area where systems are mounted and studied.

The simplicity of the structure indicates that the complex ws not primarly conceived or designed to house the solar energy research centre.

4.4.3 Circulation/ Services

all functional spaces are accessible through a 1.5m wide passage with an open courtyard. The complex is accessed through an untarred road. All toilets are conveniently serviced. Basically, the centre uses natural lighting and ventilation. The windows are recessed to avoid glare.

4.4.4 Materials /Finishes

the centre is constructed with simple hollow blocks, reinforced concrete columns, corrugated roofing sheets.finishrs include cement plaster,glass and terrazzo floor finishes.

4.4.5 Observation

A) Merits

i. the centre lacks coherence and uniqueness in charcter.
ii. Inadequate office space for thecentre.
iii. Lack of well defined pedestrian and vehicular circulation.
iv. Poor landscaping of the centre.

4.5 ENERGY RESEARCH CENTRE , SOKOTO

4.5.1 Background Information Research

research in solar has been taking place at the Usman Danfodio University, Sokoto for more than ten years. In 198, the senate of the university formally recognized the information an energy research unit that was an inter-displinary body comprising members of staff drawn from various departments of the faculty of science. Towards the end of 1982 the federal government took the decisionto make University of Sokoto now usman Danfodio University a Centre for Solar Energy Research. The centre was to conduct research and development as well as manpower training in Solar energy. The establishment of the supervision of the Sokoto energy research Centre.

4.5.2 Design/ Planning Concept

the complex is a simple rectangle of spread design concept. The complex zoned into three parts, the administration blocks; offices, laboratory, biogas, photovoltaic lab and demonstration field. The complex is a temporary site to house the activities of the centre, a it is a unit of usman Danfodio University Structures.

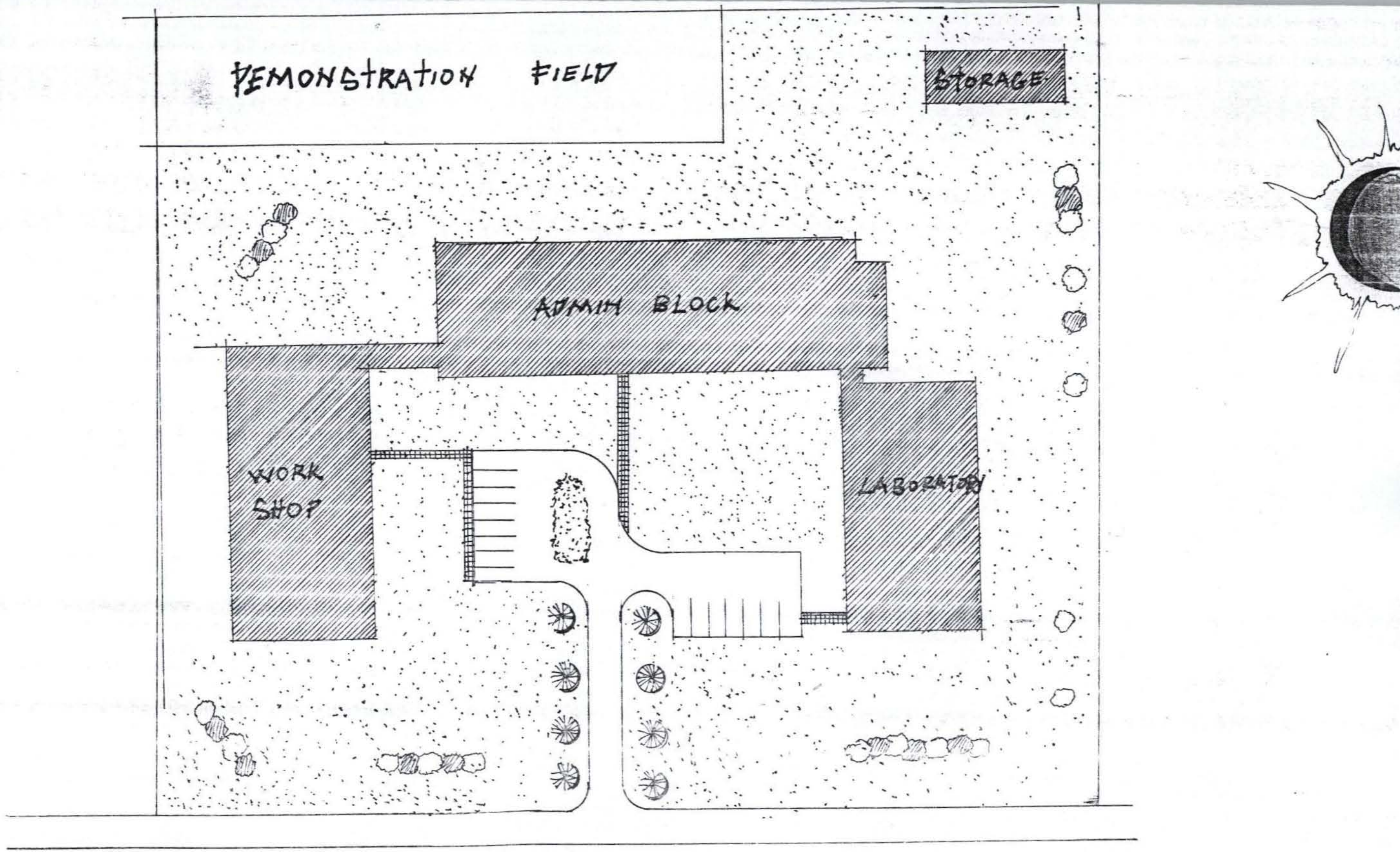
The structure was not primary designed to meet functional requirement of the centre.

4.5.3 Circulation

All functional spaces are accessed through a concrete paved way linked to a passage of 1.2m wide. The vehicular circulation pattern is nit well defined within the complex. Toilets are conveniently provided with overhead storage tanks. The centre mainly uses natural means of ventilation in supplementing Air conditional window unit with solar energy devices produced at the centre.

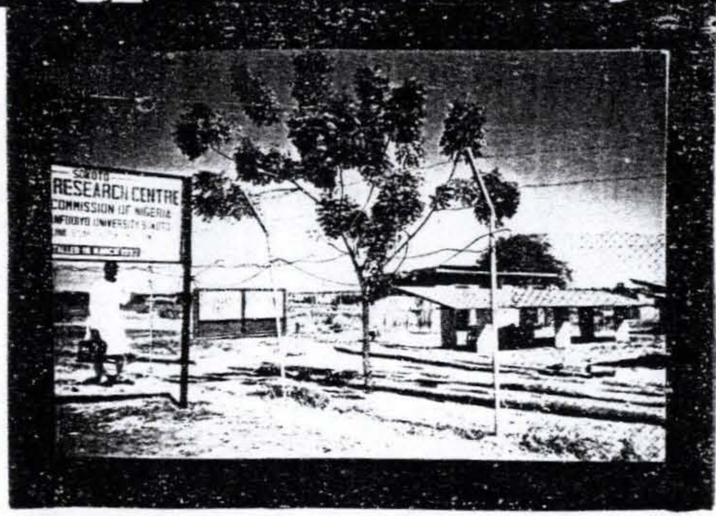
4.5.4 Materials/ Finishes

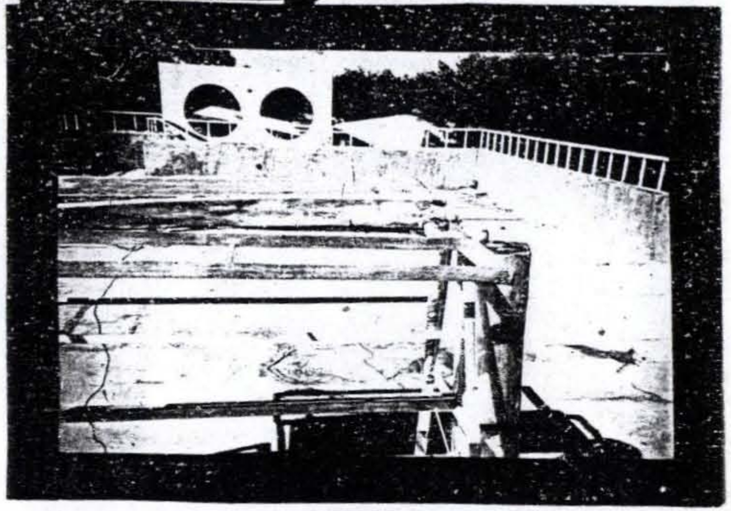
The construction materials include reinforced concrete columns, forming a modular construction method, with hollows and cement

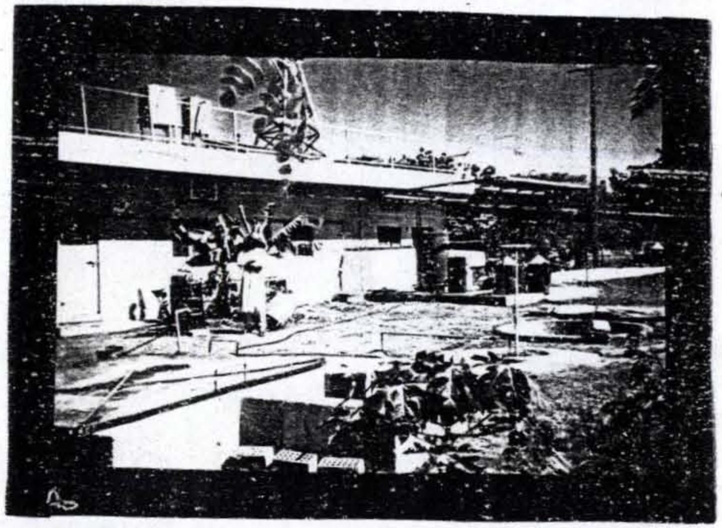


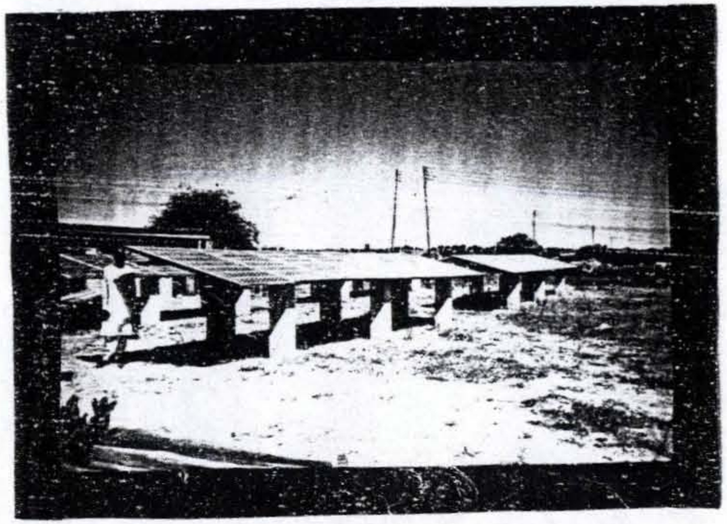
DESIGN PROPOSAL FOR

STUDY 1









plaster. Finishes include glass, reinforced concrete columns and beams, terrazzo floor finish.

4.5.5 Observation

A) Merits

i. The entire is simple and blends into the environments
ii. The separation of the conference area and offices area from laboratories and workshop is commendable.

B) Demerits

i. Inadequate offices for the centre.
ii. Poor landscaping of the centre.
iii. The composition is without a unique character.

4.6 DEDUCTION

i. The research centre visited all lacked accommodation facilities for particularly their staff.
ii. The research centre are all linked to one higher institution or the other there by not allowing the full concentration that the activities in the centre demands.
iii. And lastly since the centre were not originally made to be for the purpose it is being made to be there were a lot of lacking

facilities such as inadequate spaces for repairs and inadequate offices.

All these problems shall be tackled in the design proposal.

CHAPTER FIVE

5.0 DATA COLLECTION

5.1 CLIMATIC CONDITIONS

The climatic condition of Abuja is been determined by the pattern of variation several elements. These elements are as follows:

5.2 CLIMATES

Man's comfort is the measure of the extent to which the physical environment should be controlled. The organism should appropriately be designed for the thermal comfort of the occupants. A comfortable living environment depends on maximizing the aspects of the environment, which reduces heat, and the effect of humidity and protection from rain and dust.

5.3 RAINFALLS.

Rainfalls are seasonal in Abuja area season normally spans the period of the month of April through October and the remaining parts of the year are dry months. As with most tropical location, rainfall depth is about 1500mm in a year with duration of about 200 days in a year. The start of the rainy season in northeastern Federal capital is around 10th of April. The rain tapers off very rapidly after the 20th of October. Thus the duration of the rainy season is between 180 days to 190 days. The mean monthly distributions shows a tendency for annual rainfall is in the monthly distribution shows a tendency concentration in three or four months. In Abuja 70 % of the annual rainfall is the month of July, August and September. The F.C.T has frequent occurrence of square lines which being with dense; dark, cumulonimbus clouds with thunder and lighting followed by drizzle if several hours duration. This condition is then replaced by a few days of bright, clear skies; it is most common in late afternoons at the beginning and end of the rainy season, and after causes properly damage.

5.3 SUN RADIATION.

The sun is the main source of energy on the earth .It arrives on the earth at a maximum flux density of about 1kwm^2 in a wavelength bond between 0.3 and 2.5 cm. This is called short wave radiation and includes the visible spectrum. For habited areas receive fluxes varying widely about 3-30mjm-^{2} day-1, depending on the place, time and weather. The sensation of day and night is caused by the earth's rotation about its north-south axis every 24 hours, and at the same time makes in elliptical orbit around the sun in a north south axis inclined to the plane of orbit at 23 degree and 27 minutes. The earth makes are completely revolution in one year of 365 days 5 hours, 48 minutes and 48 seconds which gives rise to the season. The sun is said to move between the tropic of cancer 23.5 degree North and the tropic of Capricorn 23.5-degree south. In June the earth is titled towards the sun and the tropic of Cancer receives the maximum intensity of solar radiation. This is the summer solstice; with summer in the Northern hemisphere. During the winter solstice the situation is reversed with the tropics of Capricorn receiving maximum solar radiation and the northern hemisphere experiencing winter. The day is longer than the night during the summer with the reserve in the winter. In March the sun crosses the equator (vernal /spring equinox) and September (autumnal equinox). At this time, the day and the night have equal length for all places on the earth.

5.4 TEMPERATURES

in the human term , net radiation is felt as air temperature, the response to which is greatly influenced by the humidity conditions in the air. The F.C.T records its highest temperature during the dry season. Changes in temperature of as much as 170C have been recorded between the highest and lowest temperature in a single day. During the rainy season, the maximum temperature is lower due to the dense cloud cover. Human sensitivity to temperature is greatly affected by relative humidity. During the dry season relative humidity falls. In the afternoon to as much as 20% in the city the low humidity coupled with the high afternoon temperature, accounts for the desiccating effects of the dry season. In the rainy season, relative humidity is much higher especially in the morning hours when it can reach as light as 95% even thought the temperature is slightly lowers the effects creates a heat trap.

5.5 WIND DUST

Two major air masses dominate the climate of Abuja. The first is the tropical continental air mass. The tropical maritime is warm and moist, it moves on land in a southwest to northeast direction. The tropical continental air masses are over the Sahara desert and therefore are warm and dry. It blows in the northeast to southwest direction. The two air mass movement produces the seasonal characteristic of weather conditions in Nigeria. The dry season related to the former and the wet season to the latter. The tropical continental mass is associated with northeast trade winds and the tropical maritime air mass gives the southwest monsoon winds.

5.6 SUN AND CLOUD COVER

The amount of sunshine received over a particular place depends on its latitudes predominantly it increases as those areas approach the tropic than in the poles. Abuja according to sun charts is expressed to 12500 sunshine hours annually. During the dry season, the monthly radiation in amount of sunshine follows the general trend of increment over 275 hours as the wet season approaches, the sunshine hours decreases intensively. The amount of insulation gives room for the use of materials, which can reflect or absorb solar radiation in a form building.

5.7 VEGETATION

The city of Abuja is dominated by parks savannah. However rivers sides have in addition high tress and thickets. And also with few occasioned patches of forest and or heavily wooded area. Large trees on site are maintained while ultimate banks as much as possible replace thickets. This move will reduce unlimited banks. This move will reduce water borne diseases. Park savannah is stratified growing, characterized by discontinuous foliage, shrub s and grass layer. The stratums of trees however are less dense compared to what is obtained in the savannah woodland. Nevertheless it is better than that of the shrubs savannah. The composition of the park savannah mostly include thick, tall grasses, layers of Adopagan and Hyperheroa, Species and a shrub layer in terminalia, pillostrigna, Amona, Wachlea and Bombare are most common.

The savannah wood land is characterized by shrubs savannah vegetation, low levels channel banks of water course and stream valley follows after enjoys riverine forest and patches of rain forest which however varies from high forest to a mixture of woodlands, gallery forest and dense thickets. Efforts are been made to pressure woodland area in and adjacent to Abuja City. This is because the woodland are small and important for their value. As an aesthetic and recreation resources more so far they are improving to maintain as much possible, the natural vegetation on the site. The wooded area could be exploited to use the fire resistance species in making and construction of fire retardant doors and associated allies.

5.9 GEOLOGY AND SOIL

The plains within the city include the older Precambrian units of metamorphic, sedimentary rock. The major rock type underlying Abuja are described below.

The soil underlying the capital city is generally, as a type and well drained. These soils are also fertile than many soils in the F.C.T. they are generally the deposited and at least the stones of the soil derived from granites grieves and magmata that underlay the site. They have low to moderate erodibility and sun off potential texture of the soils was typical loamy sand to scanty loam on the site for the proposed research centre, the dominant types of soils are the residual great potential for intense landscape.

5.10 GEOGRAPHICAL LOCATION

Abuja a symbol of Nigeria aspiration as city of national unity lies between latitude $8^0$75'N and $9^0$20N and longitude $6^0$39 and $7^0$30east of Greenwich Meridian. Bounded to the north by Kaduna state, to the east and southeast by Plateau state, to the northwest by Kwara state and to the west by Niger state. Being centrally located, the federal capital is accessible from all parts of the country. Designed and planned to achieve a target population of 1.6 million people, by the year 200 and an ultimate size of 3.2million people when fully developed.

Abuja, the federal capital city of Nigeria is one of the most significant developing being, undertaken by the federal government. The idea of a new federal government was conceived when it was realized that the government that the continued retention of Lagos as the federal capital had become impracticable especially with its intractable traffic, having and sanitation problems and its multiple rate as a state and federal capital.

5.11 PHYSICAL AND SOCIO-CULTURAL BACKGROUNDS

Nigeria has an important urban tradition. The tradition includes how people have lived both cities with ancient roots dating back centuries and in new towns located during the colonial periods. The important ingredient in the development of Abuja is a review of the relationship that has developed between social and physical aspects in existing Nigerian cities. This basically a degree of continuity with social and physical aspects in exiting Nigerian cites. This is basically a degree of continuity with the social and cultural tradition while encouraging, where appropriate amalgamation of the various streams of urban tradition and life style into a new modern Nigeria urban context. The indigenous traditional structures of Abuja exhibit the following socio/physical characteristics.

a) Overall urban form; this is a process of accommodating the city form to maximize the site opportunities and of providing for public transportation.

b) Land residential community: within this community tradition, both the natural site constraint of the city and the resulted in a pattern of residential land development panels of accommodation local residential communities of between 3000 and 12,000 person.

c) Traditionally; the residential sub-areas have often been defined by kinship-linked cluster of household with substantial integration. Additionally, these in a high correlation between local administrative designation and local social identity groups.

There has been evolution of the traditional pattern with some element replaced by modern parts increasingly a set of social services and amenities (churches, mosques, schools, market etc) have played a role in the social focus within sub-areas or word and may even take the names of the word supplanting the traditional association structures.

Five types of factors identify a local design quality.

- Primary; spatial boundaries and local design quality.
- Service system; Facilities and service shared by residents
- Governmental; Mechanism of service communication and control between the local and various levels of formal government.
- Economic; employment and commercial establishment within start travel distances of home.

i. House hold organization; this illustrates the importance of permitting multiple options for residential layout to accommodate a wide variety of urban life styles.

Moderate residential density, which result in affordable plants and optimum combination of walking distances and services unit size which preserving enough space for the future growth and change.

ii. Central public space; It is aimed at creating a functional and organically 0wholly central area early in life of then new capital by concentrating facilities along the axis to convey a sense of competition and urbanity.

5.12 DEMOGRAPHIC AND SOCIAL ECONOMIC FACTORS

i. Population

Extrapolation from latest available statistic determine the demographic characteristics of Abuja city as it influences on the project at hand these characteristic are age/sex distribution, the number of houses holds and anticipated income distribution by the year 2000.

ii. Land use

The land use requirement were based on current Nigeria practicing new services delivery systems under development

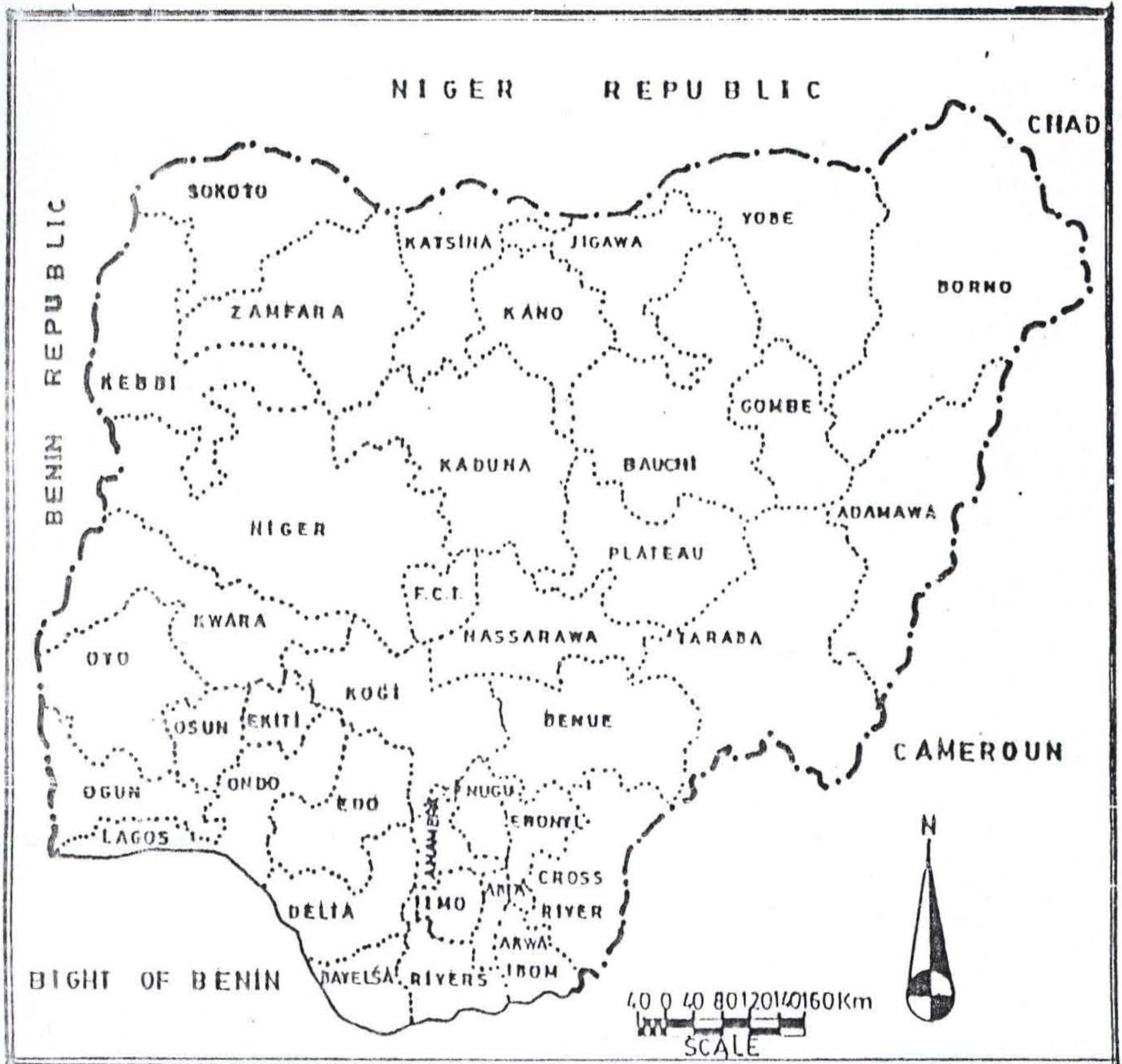
CHAPTER SIX

6.0 THE SITE

An introduction is made here to highlight the reader with a little knowledge of the city Abuja and its territory. A further expository is given on the city's physical and socio-cultural background, which have been subsequently mentioned under different sub-topics.

6.1 Abuja – The Federal Capital City

Abuja, the new federal capital city of Nigeria occupies an area of roughly 8,000sqkm, lying south of Suleja town (old Abuja). Niger, Plateau, Kwara and Kaduna states surround the territory. It is situated within the heart of the country and is about 795km from Lagos, which was the foremost capital. Abuja lies within the savannah zones of the six climatic zones of the country. The territory lies just North of the wide alluvial plains formed by the confluence of the Niger and Benue River. This territory consists of a little plain rising from elevation 300ft in the southwest corner to above 200ft at the northeast corner where the city proper is located. Rising out of the plains are numerous rocky outcrops and inselbeges, and several ranges of low maintains making for very interesting landscape that characterized the city.



LEGEND

National Boundaries. . . . .

State Boundaries. . . . .

Study Area. . . . .

Economically and geographically, the location of the federal capital territory and the planned infrastructure improvement will create a context, which is the physical embodiment of many national goods for unity.

The federal capital itself lies to the northeast quadrant of the federal capital in what is now called Abuja municipal local Government area. The city has its overall land use pattern confined to a crescent shaped site defined by the development land above 1200ft in the Gwagwalada Plains bellows the escarpment surrounding the outer area of the site including the promoting of the Aso Hills. It is bounded by the Abuja hills to the West. The Zuma-Bwari-Aso Hills of the North , the Kuru-Agwai Hills to the eats and the Zargo-Kuku Hills to the south.

6.2 SITE SELECTION CRITERIA

The selection of the site for the thesis was based on an evaluation of region where the sun's radiation can be felt to an appropriate high level as well as it's been centrally located. Some other factors are

6.2.1 Micro Selection Factor

These are,

1. **Urban Habitability**: - hability of an urban environment is defined by a combination of environmental factors including soil

characteristics, vegetation, quality, geological characteristics, probable conservation zones, quality of climate and suitable of terrain. By itself, no environmental factor is particular meaningful to accredit location for research. Unless it is interpreted and made relative to some other factors which may transform such a factor either into useful or useless measures for site selection. The following correlating factors were considered in conjunction with the aforementioned factors;

i. Most comfortable and healthy site
ii. Suitable climatic conditions
iii. Adequate/ sufficient size to allow for future expansion.
iv. Buidable soil not requiring special engineering measures for constructing.

To be able to find whether an environmental character is suitable for the purpose in question, such as character must be tested under the following negative criteria;

A. Slopes of 15%; - some sites present construction problems through their slopes. Buidable slopes ranges from 3% to 15%. Slopes over 15% are not suitable.
B. Poor soil: - poor soil is a soil type characterized by
    i. Many types of laterite
    ii. Valuable drainage
    iii. High propensity to erosion
    iv. Medium drainage density.

C. Riverine, rainforest and swamps: - these are very expensive to develop.

2. **Accessibility**: this criteria is preferably treated on it's own simply because of it's importance. Some sites may be habitable, but there may not be an easy access to it.

6.2.2 Micro Selection Factors

These are man-made constraints, which includes adequate space, water, power, waste disposal, playing require and infrastructure services.

6.3 SITE ANALYSIS

6.3.1 Location

The chosen site is located in kuchin boro, not too far from the Abuja city gate. It is located along the airport road. The site is a bit on the outskirt of the main town, but easily accessible because of the major road that passes in front of it. Also the site is not in an obscure area as it can be seen from the main road. View of the site is generally good and interesting with a vast expense of bush green fields. The major source of noise is from the major roads and due to vehicular.

6.4 CRITERIA FOR SITE LOCATION

First and foremost, the choice of Abuja is a result of availability of sunshine at different point on the vast land mass that the state is adored with, and the choice of Abuja can supply facilities that can not hamper research activities when they are in progress such as good water supply good drainage systems.

. 6.4.2 Land Acquisition

The possibility of acquiring land at a cost in proper relation to total capital cost and obtainable rent is another raised for this site. Bearing in mind an adequate size suitable shape to permit proper [planning of the merchandising area.

6.4.3.1 Area Of Site

The site covers a total area of land. This gives room for the erection of the necessary facility need in the research centre.

6.4.4 Site Viability Factors

The site is not centrally located within the city. This singular demerit has been overwhelmed by the numerous merits associated with it. A research center is a place where enough vast land should be available for it. These characteristics are not only for the control of security alone, but also for adequate availability of size of land needed for the necessary facilities.

6.4 Site Accessibility

The site is easily accessible from the city gate. This is being made possible by the construction of secondary feeder road, which is tapped from the Abuja –Suleja road. With the effective network of well planned tarred, access to the site is very viable as it is presently linked up. Vehicles easily reach the site from other towns easily.

6.4.5 Site Geographical/ Geographical Factors

The effect of the site geographical factors on design cannot be overemphasized. The most relevant things are soil, topography and vegetation. Generally, the soil underlying the site area is predominantly derived from granite and their suitable for development varies with depth. By observation, the entire site is relatively flat in terrain.

6.4.6 Site Climatic Factors

The basic climatic characteristics of the site via Abuja have been discussed in previous chapter. However, the basic climatic elements like sun, wind, precipitation, and temperature have tremendous influence on building design in a given locality.

6.4.7 Utilities On Site

Also the area been of such that is allocated for research purpose, all utilities are made available in the area that will be so demanded of a research centre. Such as installation of transformers of high voltage, connection points for water, and those not currently on site, provision has been made that they will be installable at acceptable cost.

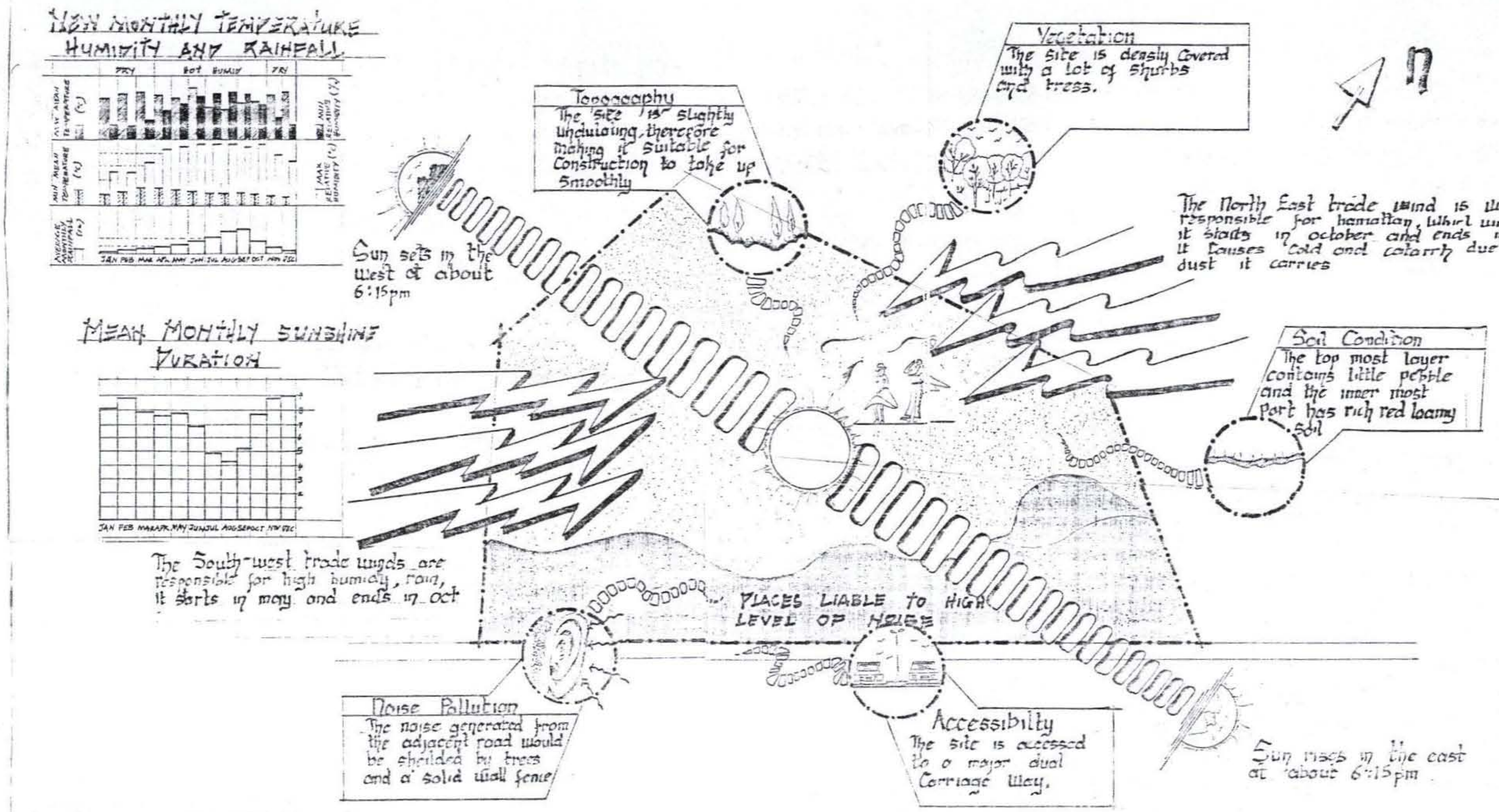
There is no easement or other legal restrictions that will interfere with proper planning and there is o undue topography that could have inflate the grading cost and screw any plan for an economical construction. The area obviously is not without its own flaws, however a weigh and balance of the advantages against the shortcomings, has given this location an edge over any other option.

6.5 PREVAILING WIND

The site like other part of the town, is under the influence of two major air masses

i. The tropical moisture and
ii. The tropical continental air masses.

The tropical maritime dominated over Atlantic Ocean to the southwest toward the southwest towards the northeast. While the tropical continental is dominated over the, warm and dry and move from northeast toward the southwest



DESIGN PROPOSAL FOR

SOLAR ENERGY RESEARCH CENTRE

WITH EMPHASIS ON NATURAL VENTILATION — ABUJA

The wet season is caused by the maritime called SOUTHWEST TRADE WIND and the continental cause dry season, and it's called NORTHEAST TRADE WIND. The duration and intensity of each wind [season] is a function of the interface between the two air masses.

6.6 TOPOGRAPHY

In comparison with the entire town, the can be said of to a plain ground. However, it exhibits a very gentle slope in the southern direction along the road. Abandoned recovered earth on some part of the site makes it more rugged- but those are simply artificial relief.

6.7 RAINFALL

The site on a deduction from the data on Minna, it records a mean annual rainfall of 1640mm and raining season that last for 5-6 months in year. It has its maximum rainfall in the month of August each tear. [See rainfall chart].

6.8 VEGETATION

There is sparse vegetation on the site with grasses on most parts of the site and only two notable trees, with some shrubs of about 600mm to 900mm in height. The grasses are only green in raining season, but become arid immediately the season of rain over.

However, I do know that trees, palms, and flowers will thrive on the site, if planted under a well-watered atmosphere.

6.9 SOUND AND NOISE LEVEL

Although the site is an area marked for research, however, the current noise level is surprisingly low. The few source of sound on the site comes from the road; it is a busy road, an advantage to the goal of the project.

6.10 DEDUCTION

In conclusion, having subjected the site to a physical and economical analysis, i.e. having established the fact the site has all the potential for a moderate research centre. And also establishing other factors as: -

i. The good road network, which will enhance the smooth transportation of solar panels.
ii. The site is accessed from a motorable way.
iii. Easily accessible and some other related factors.

A conclusion has been drawn that despise its shortcomings as express in the analysis; the site is most suitable for maximum research findings and training.

CHAPTER SEVEN

7.0 DESIGN REPORT

7.1 DESIGN BRIEF

The centre will be provided with the following facilities for operational convenience, administration research and training, services and maintenance, laboratories, workshops, computer room auditorium, library, testing areas and housing for temporary staff and students.

7.1.1 Design Parameters

Administration

i. Main entrance
ii. Offices for internal administration and coordination.
iii. Provision for general public information on research results.
iv. Provision for local and general public information on research results.
v. Some unallocated offices for unforeseen uses.

Ancillary facilities

i. Staff canteen
ii. Health publication unit.

iii. Computer unit.

Service, operations and maintenance

i. Offices.
ii. Central storage.
iii. Workshop

Research and training facilities

i. General laboratories
ii. Offices for research staff
iii. Offices for training staff
iv. Administration for research unit
v. Administration for training unit
vi. Seminar room
vii. Library

Meteorological observation plots

i. Demonstration field
ii. Meteorological observation platform
iii. Area for installation of wind mills
iv. Store

Housing

i. Student accommodation
ii. Staff housing
iii. Guest houses

Security

i. Gate house with guards at access point
ii. Fence round the centre

7.1.2 Administration unit

The administration units consist of the following major departments; personnel technical health services and catering department.

A. Personnel department

The personnel department is responsible foe keeping the personnel records and managing the employee's benefits. This department is also concerned with recruitment of staff, organizing training for staff both within and outside the set up to their standards.

B. Technical services department

The technical services department undertakes the fabrication of some requirement used for researches; maintenance of furniture and other equipment used in the centre could be carried out in this department. Servicing of some research equipment could also take place here.

C. Health service department

The health centre has the status of a clinic. Major cases should be referred to the hospital. Bed rest could be given to some weak staff that requires rest for some hours.

D. Catering department

The restaurant serves the whole of the centre. A contractor should undertake the services here; adequate provision is given to the kitchen, store, servery and conveniences.

E. Finance unit

There are four major department that make up this unit, namely accounting, budgeting, purchasing and central store. Excessive expenditure by any department in the centre can be controlled through this unit.

F. Information and education unit

The major department contained in this unit is public affairs, word processing, library, consultation and data bank.

G. Public affairs office

The office is responsible for public information and contracts with information media. It will prepare press releases, including photographic coverage of the centre events.

H. Library

The library in this department provides information to both staff and the public under special arrangement. It can be as a reference library for books and journals. It could be used for general reading and study.

I. Auditorium

The main function of the auditorium is for organizing conferences and seminars. Occasionally, public lectures could be given in the auditorium; provision would be made for projecting films if the need arises.

J. Computer department

The importance in research cannot be overemphasized.

K. Research and training

The research unit is provided with laboratories, offices for research, library and administration department. Areas of research to be covered include:

i. Materials.
ii. Photovoltaic cells
iii. Thermal conversion
iv. Bioconversion
v. Components and systems
vi. Wind energy
vii. Energy conservation and management

7.2 SITE ZONING

The entire complex has been divided into public, semi-public and private areas. Within the public areas fall the parking spaces, and administration. The restaurant, auditorium and accommodation fall under the semi-public area while the demonstration site laboratories and workshop fall under the private area.

7.3 SITE CONCEPT

The site for the project is generally a sparsely vegetated land. There is likeliness of noise pollution on the site. The planting of tall trees and a solid fence wall would break this pollution effect. The trees at maturity will serve as windbreaks and filter dust from winds blowing across the site. The trees may pose a threat if planted very close to the building and may prevent the solar panels mounted on them from collecting maximum amount of solar radiation. For security reasons, only two roads have been provided as entrances and exit to and from the site. Grasses and water bodies will also be provided to reduce the effect of dust.

7.4 MATERIALS AND CONSTRUCTION

7.4.1 Building Materials

The array of available building materials for use is extensive in addition as extensive as they are, so as extensive the purpose for which they variously apply. However, choosing a building materials type depends on the following factors

A. Availability: the materials must be readily available for use whenever needed.
B. Durability: the materials must be of the type that is able to survive the actions of the elements under given circumstances.
C. Cost: only materials, which are affordable at the time, shall be specified for a purpose.
D. Suitability and aesthetic: Airapeter D. in his book, Architectural materials science said that the technologies of materials and optimum application, technologies of materials are very important in architectural profession. In the past, it however, the reverse is the case "architecture follows materials. Today however, the reserve is the case "materials follows architecture". This belief to be the result of recent advancements in science and technology of architectural materials.
E. A good knowledge and understanding of building materials are of great usefulness to all persons whose professional activities are in one way of another interwoven or associated with architecture and building

7.4.2 Concrete

Concrete is to be used widely during the construction of this proposed library. Concrete is a building material consisting of a mixture in which a paste of Portland cement and water binds inert aggregates into a rock like mass as the paste hardens through chemical reaction of the cement and water.

Sand, gravel and crushed stones are the common aggregated used in concrete preparation. The aggregate should be clean, and free from soft particles and vegetative matter. The type of concrete mix used is to determine by the purpose for which it is intended. If too much water is added to the mixture, the paste becomes thing and will be weak when it hardens. The strength of the cement paste and of course the durability, strength, and water tightness depends on the amount of mixing water used. Prescribed mixes are used in place of the traditional nominal volume mixes such as 1:3:6 cement, fine and coarse aggregate by volume, which have been used in the past.

7.4.3 Concrete Blocks

These are to be used extensively for load bearing walls. A concrete block wall can be laid in about half the time and it costs up to half can be much as a similar brick wall. These blocks have good insulating properties against transfer of heat. The lightweight aggregate concrete blocks to be used are made of Portland cement

The usual mix is 1 part of cement to 6 or 8 of aggregate by volume. These blocks are to be manufactured as solid and hollow.

7.4.4 Timber

The word timber describes wood, which has been cut for use in building. Timber has many advantages as a building material; it is a lightweight material to be used for roof panels and frames, rafter and plate walls and doors.

As a structural material, it has favorable weight to strength good modulus of elasticity rations and coefficients of thermal expansion. With sensible selection, fabrication, fixing and adequate impregnation or protection, it is a reasonable durable material in relation to the life of most buildings.

7.4.5 Aluminum Sheets

Aluminum roofing sheets is to be used for this proposed complex. Long span Aluminum sheet come in different colours. The pure aluminum sheets containing at least 99% aluminum and a gauge of 0.75 millimeters is to be used. These sheets have moderate mechanical strength and can readily bent and beaten into quite complicated shapes without damage.

7.4.6 Bituminous Felt

This is one of the cheapest and most commonly used roof coverings and for this proposed complex, three layers of this felt is to be used for flat roofs. This felt will however be laid to a shallow fall of at least 1:80 to encourage run-off of rainwater.

Glass: Glazing of one way visibility which would permit view of the outside from the inside in order to give the user of the library a feeling of interacting with nature while working. The glass to be used is the solar control glass.

7.5 CONSTRUCTION

7.5.1 PLANNING PRINCIPLE

The structural and functional stability of f every building is dependent upon load distribution and transfer. The principle of planning this research centre is one that allows for flexibility in the use and allocation of space. The structural framework is composed of beams and columns that transfer load to the substructure. This allows for partition walls to be non-load bearing; that way a partition wall can be knocked down without disturbing the main structure. This enhances flexibility as the use of spaces can be changed any time.

7.5.2 Burglar Proofing Materials In Buildings

Burglar proofing is employed in construction to prevent the ingress of thieves (burglars) into a building. Materials used for achieving this, are strong resilient materials that can withstand impact. Such materials as steel bars; aluminium section, masonry concrete and brick are in use.

7.5.3 Steel

Steel is the most popular burglar-proofing material. Steel is strong, can withstand impact and very resilient. With its small sections of usually sound bars and diameters ranging from 12' – 40mm, burglar proofing can be achieved over an opening without obstructing vision. The material (Steel) can be arranged and welded in various patterns with openings that will not pass a human being (usually the openings are not more than 150mm wide).

7.5.4 Fixing Of Burglar Proofing Materials

Fixing of burglar-proofing materials determines their effectiveness in shielding an opening. High standard of workmanship is required as any weakness in the joints renders the burglarproof defective.

However, maintenance is undertaken in order to keep, repair, improve every facility i.e. every part of a building, its services and surrounding to a currently accepted steward to sustain utility as value of facilities.

The functions of maintenance include:

(a) To prevent or diminish significantly deterioration of the fabric.

(b) To maintain decorative surface and carry out adequate cleaning.

(c) To ensure the safety of the occupants, visitors and other people in a building.

(d) To maintain services e.g. air-condition, fire alarm system, heating and lighting.

The component of maintenance includes planned maintenance and unplanned maintenance.

Planned maintenance is a maintenance organized and carried out with forethought, control and the use of records to a pre-determined plan. Unplanned maintenance is maintenance works that is due to unexpected or unforeseen situation or circumstances. Benefits of maintenance are that people are more confident and carry-out their duties more efficiently in a building that is well maintained well maintained building are easier to manage and plan for an early detection of and defective part of a building, arrests or reduces deterioration and thereby avoid possible catastrophes.

7.5.5 Site Investigation

Before construction, it is important to carry out site investigation on the site to determine its suitability for building and nature and extent of the preliminary that will be needed, particularly the nature of the soil. The position and size of the main service should be determined. The nature and condition of site boundaries should be noted together with the extent of the site clearance work such as buildings to be demolished and trees and shrubs to be removed.

Water content of the soil need to be drained to prevent the passage of ground moisture into the buildings.

7.5.6 Foundation

The type of foundation used depends on the condition of the site. Foundation like pad (continuous) and pile can be used due to moisture of the soil (waterlog), which will require some ground modeling. Consultation will still however be made to the foundation engineer to evaluate and determine the most economic type.

7.5.7 Super Structures

This should be achieved by frame construction techniques using reinforced pre-cast modular element. The retaining wall of the floor slabs should be reinforced concrete.

7.5.8 Finishes

In selecting wall and ceiling finishes probably the two most important consideration are appearance and maintenance costs. Also important are resistance to consideration, acoustic properties and provision of a smooth even surface.

All surfaces in this design shall be of 20mm masonry cement plaster rendering.

External walls shall be painted matt finishes. This is because matt finishes avoid reflections of light sources and minimize surface irregularities. While all internal walls shall be painted texture paints. They have weather shield and fire retardant properties.

7.5.9 Landscapes And External Works

Grasses areas and roadside verges possess great amenity value and also perform useful functions such as absorption of sound and reflection of glare.

The finishes surface should project 20mm above adjoining surface, such as gravel or ballast treated with weed killer between grassed areas can be constructed with various materials and the choice will be determined largely by such factors as initial cost, maintenance cost, appearance wearing quality and non-skid properties. Pre-cast concrete paving slabs or flag shall be used for walkways. It will be used alongside rubble stone paths.

7.5.9 Windows

All windows frames are to be of the aluminum type. The dimension types of the windows are related to structural module

7.5.10 Walls

The walls are made of sand Crete blocks. They are plastered with sand and cement mix after which they are painted with texcotes paint both on the inside and the outside.

7.5.11 Floor

The types of floor finishes to be used are dependent upon the functions to be performed in within such areas. For low noise areas, P.V .C tiles are to be used, as they are quite and resilient. For noisy and heavy traffic areas, terrazzo tiles are to be used. For quite areas, rug carpet is to be used.

7.5.12 Ceiling

On all the floors except the last floor, waffle grid is to be used. It is made of concrete. This apart from been aesthetically sound, structurally it helps transfer structural load to the columns and to the substructure.

CHAPTER EIGHT

8.0 DESIGN SERVICES

The physical climate within a building is controlled by its services. These services, which are necessary to ensure that human activities can be carried out conveniently and comfortably, include

8.1 ELECTRICITY

A constant supply is absolutely essential for the smooth running of the research centre except for that electricity will be generated fully on the solar panel but the main electricity supply from NEPA would act as an alternative. Apart from controlling the climate within the buildings, electric power is also used to operate the much equipment used in the research centre.

Abuja has already been connected to the National Grid, but as the National Electric Power Authority does not give constant supply

8.2 LIGHTING

Day lighting and artificial lighting have the same general goal of supplying enough quality light while 'minimizing direct glare, veiling reflections and excessive brightness ratios'. To achieve effective lighting, certain strategies have been employed. Properly orienting buildings so that most openings are in the North- South direction. Selection of light finishes to aid the distribution and penetration of daylight. The ceilings have highest reflectance factor (i.e. lightest color or shade of color) and the floor, the lowest. Fluorescent bulbs are specified foe artificial lighting because they give light with almost the same effect as natural light.

8.3 HEATING AND COOLING

Heat gain in buildings is usually by conduction through the walls, insulation through windows, from occupiers of the building and the appliances they use; while heat loss occurs through evaporation, natural ventilation and mechanical aids, so that in equilibrium the heat gained is equal to the heat lost.

In Nigeria and other tropical countries, heating is required for only a short period and that is during the harmattan, particularly in the northern regions where it is usually severe. But people do not install heating equipment, as it would be uneconomical, seeing it would be in use for a relatively short period of the year. The problem for which a solution has to be found is therefore that of overheating. This can be solved through careful selection of building materials, the use of courtyards and mechanical aids.

8.4 VENTILATION

Haris (1983,) defines ventilation as " the process of supplying air to buildings in the amount to offset heat and contaminants produced by people." Ventilation can be achieved to a large extent by adequately ventilating the rooms and through proper zoning. Mechanical aids would also be employed to circulate clean air.

In Nigeria, heating of rooms is not always done because of its geographical location. For the purpose of this design cooling and ventilation would be adequately taken care of through the provision of windows facing the directions of the trade winds. Adequately enough windows would be provided.

8.5 WATER SUPPLY

As stated earlier, the environ of Abuja has one of the cleanest water supply in the Nigeria is supplied water from the Water Works.. Nevertheless, overhead tanks would be provided for departments such as the laboratories, students and staff accommodation.

8.6 DRAINAGE AND SEWAGE DISPOSAL

The site slopes towards the east, consequently, gutters and drainage would be constructed to channel surface and storm water in that direction. Septic tanks and soakaways would also be constructed to treat solid wastes and foul water.

There is a system of pipes, generally underground used to convey the discharge from roofs, paved areas and sanitary fitting to a point of discharge or treatment.

8.7 REFUSE DISPOSAL

Inflammable materials would be burnt in an incinerator constructed of clay blocks and located in such a way that wind would not blow smoke towards the buildings. Recyclable wastes such as empty bottles, cans and cartons would be gathered at a central point to be collected by the municipal's refuse collecting vehicle.

8.8 ACOUSTICS

Noise, unwanted sound, can be controlled by proper construction of walls, ceiling, floors doors and windows, and through careful selection of finishes. Also, adequate waiting area has been provided so that people do not wait along the corridors and generate noise.

8.9 FIRE SAFETY

Fire destroys lives and property, is easy to kindle but difficult to put out and the risk of its occurrence cannot be totally eliminated. Preventive and protective measures have therefore been taken to ensure minimum damage in the event of a fire incident.

Walls are constructed of stabilized blocks, ceilings of well-seasoned timber and floors of concrete. Also, extinguishers will be mounted along corridors. Finally, the entrances and exits of the buildings are readily identifiable.

8.10 SECURITY

A lot of expensive equipment and gadgets are used in the research centre. There is also the need to ensure safety lives and property. Securities check points are located at strategic points (i. e. at entrances and exits) of the centre, reception desks at the entrance to every building so that the human traffic going in and out can be monitored. Burglary proof will also be fixed in the windows.

8.11 MAINTENANCE

Materials and finishes employed in this design are durable such that maintenance costs has been greatly lowered.

8.12 SOLAR CONTROL

Harmful solar effect is minimized within and around the buildings by proper zoning, use of roof overhangs and parapet.

CHAPTER NINE

9.0 Conclusion And Recommendations

9.1 Summary

A research topic as this "Abuja solar energy research centre " should be given adequate attention having seen the enormous potential of this new discipline in this ever-changing world. Abuja to its credit has the generosity of abundant solar radiation due to its geographical disposition. If this natural endowment is judiciously harnessed as suggested by the researcher of this project, a complete renaissance will be inevitable in the energy sector, since virtually everything that boarder around mankind and life evolve around this subject, then we begin to consider a dawn of a new era in every facet of human endeavour.

9.2 Conclusion

The precepts laid down in this thesis work were arrived at from exhaustive research which if religiously followed will no doubt act as a pointer to the new world that has up till this moment remained a mirage in most developing nations and Nigeria in particular.

Nigeria has abundant countrywide availability of sunshine of average 3.5-7.0kwh/m^2/day to meet alternative energy requirement and to save available conventional wood, fuel and other sources of energy in the country. No doubt there has increasing awareness and recognition of the importance of ensuring the growth in research development and application of solar energy in the country is inhabited by the main factor that include; the poor technical and industrial bases for the manufacture of indigenous solar device components, the worsening economic situation in the country, the lack of adequate information or literature on solar energy systems or materials and small levels of adequate information or literature on solar energy systems or materials and the small levels of involvement of the government and communities on solar energy application programme In the country.

The Abuja Solar Energy Research Centre when finally realized would have the following to offer: -

i. Promotion of science and technology in Nigeria especially in the field of Solar Energy.
ii. It will create a forum for convergence and distribution and technological information on solar energy.
iii. Public awareness on the use of solar energy will be improved.
iv. The inclusion of training unit will with time, solve the nation's energy manpower needs.

9.3 Recommendations

Nigeria is one of the nations interested in alternative source of energy rather than over dependence on petroleum or fossil fuel, which have gained the reputation of the main source of energy, unfortunately its lifespan may be decades away.

Despite the fact that the levels of awareness among the populace is rather low, effort should be made to power supply, which can sustain the demand of the people. This could be achieved through conferences, workshops, seminars and electronic media.

The building accommodates the facilities meant for operational convenience, the structural envelop or fabric should be original as much as possible, the use of local building materials should be employed as much as possible, a very health maintenance culture should be practiced.

If all these factors are put in place and carefully considered, Nigeria will no doubt be justified for regarded as the giant of Africa.

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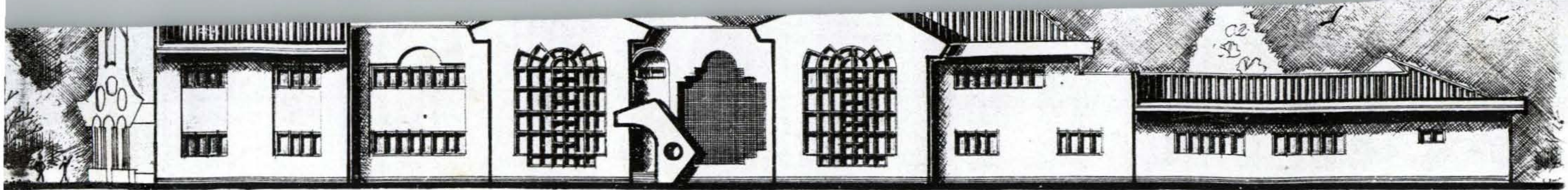
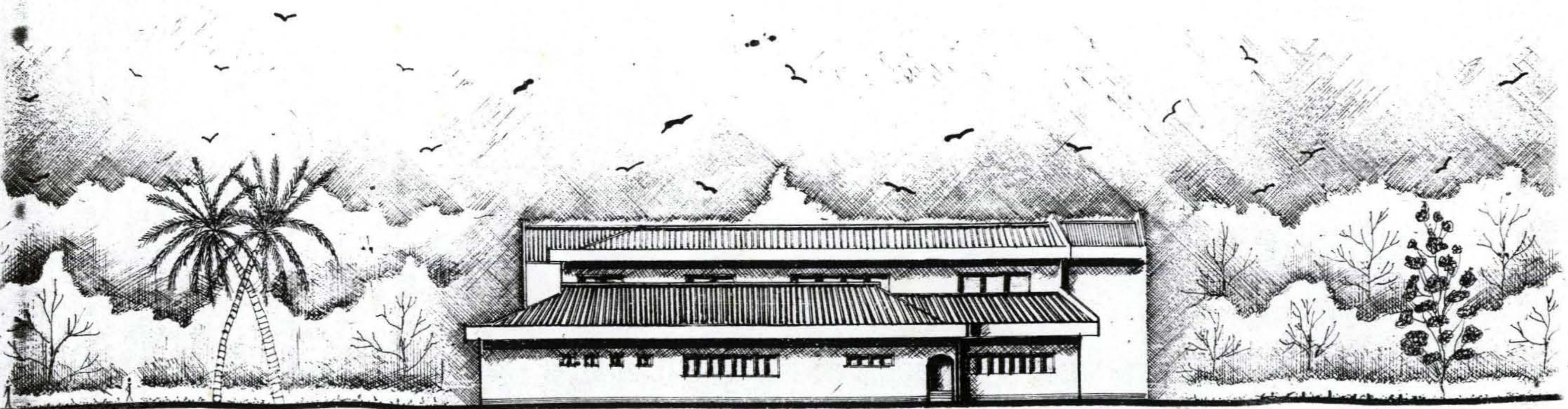
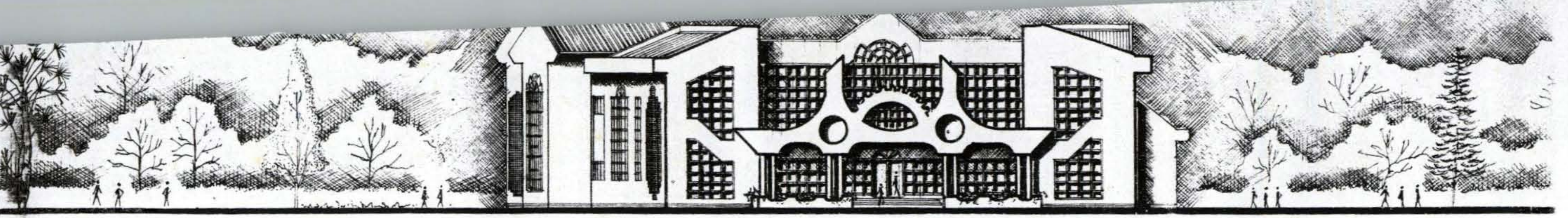


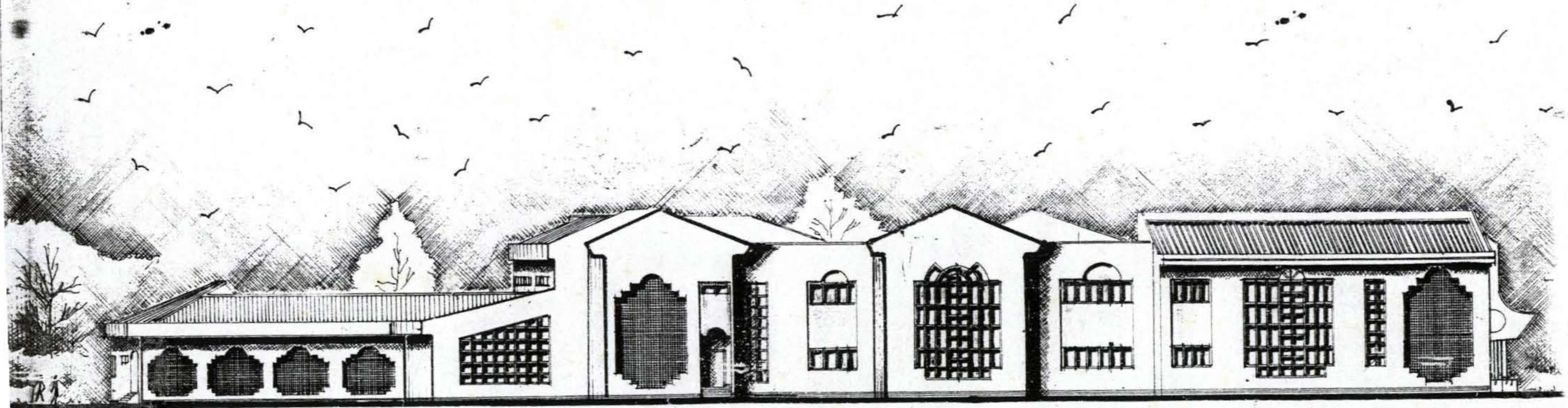
RIGHT SIDE ELEVATION



REAR ELEVATION



FRONT ELEVATION



LEFT SIDE ELEVATION