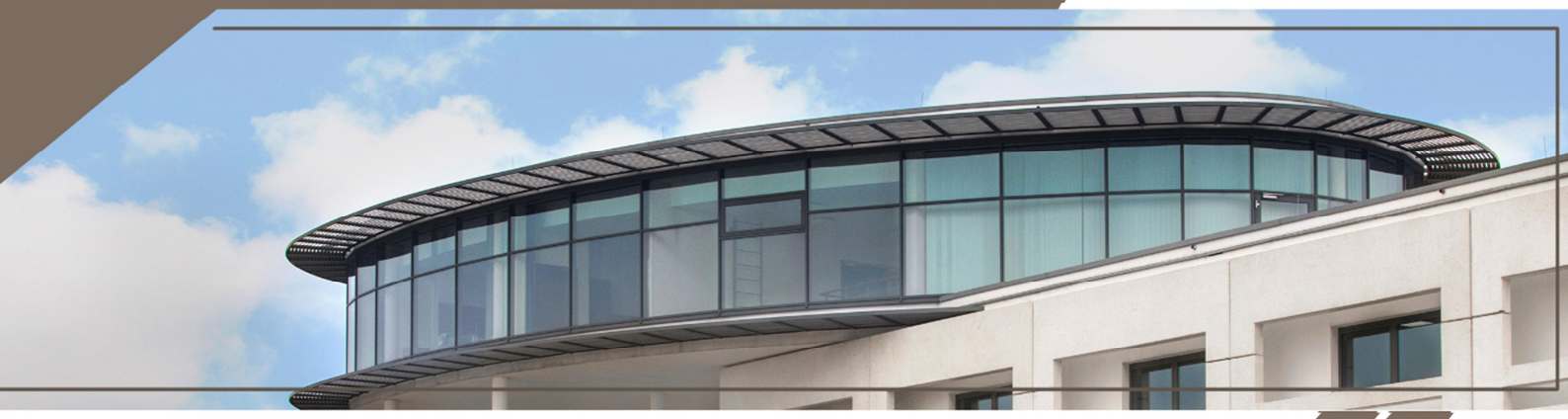
SYLLABUS AND
TEACHERS' REFERENCE



ENERGY EFFICIENT BUILDING DESIGN

European Union

german cooperation
DEUTSCHE ZUSAMMENARBEIT

USAID
FROM THE AMERICAN PEOPLE

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Energy Efficient Building Design (EEBD)

Syllabus & Teacher's Reference for a 120-hours training course for architects and engineers
2nd Edition • February 2017
Developed in pursuit of conformity with the Nigerian Competency Standards for Clean Energy | Released 2016 in the domain "Energy Efficient Building Designing"

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Content

ABOUT

This document seeks to guide trainers on the delivery of the training course Energy Efficient Building Design. The topics and subjects contained are a result of the needs expressed by the clean energy private sector in Nigeria conducted in 2014 and Competency Standards evolved together with the industry in 2015 and 2016. This document is expected to be reviewed periodically to reflect changing needs of the Nigerian market.

Course objective	Enable building design professionals to plan and design thermal and electrical energy conservation concepts as part of building design while considering the economics – in conformity with the requirements of the **Nigerian Competency Standards for Clean Energy** | Release 2016 in the domain *"Energy Efficient Building Designing"*.
Target group	**Architects, builders and engineers**
Recommended entry criteria	Minimum HND or university degree with 2 years' experience
Duration	120 hours recommended (equivalent to 15 days at 8 hours per day)
Class size	14-18 trainees recommended
Expected tasks and duties	▪ Design an energy efficient building in accordance to the BEEG ▪ Simulate the comfort and energy performance of a planned building ▪ Analyse the comfort and energy performance of an existing building
Teaching methods	▪ Lectures (presentations and videos) ▪ Group work (design exercises, role play, presentation) ▪ Pop-quiz ▪ Field trips and study tours ▪ Handouts, literature ▪ Demonstration ▪ Discussion
Assessment methods	▪ Examinations, exercises, design studies

1.1. USING THE SYLLABUS

The content of each course module is broken down to topical levels. Key information guides the trainer on the following:

- **Competency levels** the student is expected to attain at the end of the module. There are four levels of competency detailed in this document:
  - Skills and competencies required by the trainee for knowledge purposes only are classified as "**To know"**. This is the simple most level.
  - Skills and competencies required for explaining to third parties are classified as "**To understand"**.
  - Skills and competencies required for day-to-day work on an as-is basis in respect of the handbook are classified as "**To use"**. Training on practical examples, for instance, is essential to attain this.

  - Skills and competencies for day-to-day work which need to be adapted to practical contexts are classified as **"To apply".** This level is the most demanding and requires application in areas beyond what has been learned.
- Appropriate **teaching techniques and methods** for effective delivery of contents.
- **Activities** to aid effective knowledge transfer.
- **Materials and equipment** required for training activities.
- **Key resources** for trainers to study to ensure the depth and breadth of their knowledge exceeds that of the Course Handbook.

1.2. COURSE DURATIONS

The recommended contact hours for delivery of this course is **120 hours**. This would translate into 15 days of training for a fulltime delivery of 8 hours per day.

For effective delivery, the course is designed in modules, each with recommended duration of delivery. The recommended amount of time to be spent by the students in specific learning environments is suggested in the following groups:

- **Classroom:** Duration suggested in a classroom setting where techniques such as discussions, role plays, and interactive sessions, exercises presentations are deployed to *engage* the students apart from traditional teaching.
- **Field trips:** Duration suggested for engaging in practical aspects. This could be field trips, site visits, laboratory experiments or any other form of engagement *practical* in nature.
- **Spare time:** Contingency kept aside to use at discretion of the trainer. The trainer decides what environment to use the spare time for based on the response of the class to course content.
- **Additional self-study:** Duration the student is expected to engage in self-study and research complementing classroom and practical time.

1.3. ACTIVITIES

Various activities are required for the successful delivery of the course. These include:

- **Demo:** Concepts or aspects are being demonstrated to students.
- **Exercise:** Activities that require the student to solve problems in the classroom.
- **Experiment:** Carry out practical exercises in a controlled environment, usually the laboratory.
- **Interactive session:** Sessions where students are engaged in open discussions to share their views with the class, thus sparking intellectual debates.
- **Role play:** Students to perform roles they are expected to assume or encounter in the workplace.
- **Site visit**: Field trips that serve as a means of buttressing the point made in class by providing the students with tangible evidence/experience of concepts taught.
- **Video:** For introduction and support of concepts taught in class.

SPECIAL SYMBOLS

⌘ Indicates *material* available in softcopy in the package folder.

♦ Indicates *resources* available in softcopy in the package folder.

1.4. MATERIALS AND FACILITIES

To successfully deliver this training course – particularly in view of the skills acquisition, certain materials and equipment are required. A careful review of this section is warmly recommended well ahead of the delivery of the course to ascertain availability, verify operating status, initiate procurement or repairs and provide alternatives wherever the originally recommended item is unavailable. The success of this training course vitally depends on practice on such material and equipment encompassing:

- Literature, standards, Building Energy Efficiency Guide for Nigeria (BEEG)
- Infrared thermometers for of air temperature, surface temperature and air humidity
- Lux-meters for illuminance, luminance and radiation
- Software for the computer-lab and for individual participants' computers

Minimum requirements for class of 18 students	*Quantity*	*Approx. unit cost*	*Approx. total cost*
Computer per participant	Lot		
Cardboard strips	Lot		
Pin board	2		
Laptop	1		
Projector	1		
Whiteboard	1		
Whiteboard markers	Lot		
Coloured pins	Lot		
Loud speaker	1		
Building Energy Efficiency Guide (BEEG) for Nigeria	25		
Infrared thermometer – ScanTemp RH-896	4	NGN 70,000	NGN 280,000
Luxmeter – RadioLux 111B, PRC Krochmann	4	NGN 220,000	NGN 880,000
CAD drawing tools for architectural design – For 2D: Draftsight, FreeCAD, Open Scad or similar For 3D: SketchUp or similar	25	freeware	freeware
Thermal building simulation tool – EQuest	25	freeware	freeware
Lighting simulation tool – Relux Suite	25	freeware	freeware
Urban design simulation tool ENVI-MET BASIC	25	freeware	freeware

Prices are as at August 2016

1.5. TRAINING COURSE OVERVIEW

Module 1. Introduction on building physics	*8 hours*
Content	1.1 Application of thermodynamics in building physics 1.2 Energy balance of buildings 1.3 Glossary of building physics
Recommended time allocation	8 hours Classroom +2 hours Additional self-study
Learning outcomes	At the end of the module the learner is able to: ▪ Identify the basics of heat and moisture transport in buildings ▪ Define the energy balance of buildings by heat transfer calculations ▪ Identify different building heat gains and cooling loads

Module 2. Design strategy, task, climate and boundary conditions	*8 hours*
Content	2.1 Objectives of energy efficient building design 2.2 Integrated design strategy 2.3 Climate, micro climate, urban design
Recommended time allocation	8 hours Classroom +2 hours Additional self-study
Learning outcomes	At the end of the module the learner is able to: ▪ Distinguish between traditional, standard and best practice buildings as relating to energy efficiency ▪ Identify appropriate methodology and tools as well as professions for integrated design process of energy efficient buildings ▪ Identify climatic factors, sun path and boundary conditions that influence design of energy efficient buildings ▪ Define design task by requirements of comfort, energy and costs as well as social factors

Module 3. Passive and active means for energy efficient design	*40 hours*
Content	3.1 Bioclimatic building design 3.2 Passive measures of comfort and energy efficiency 3.3 Active measures of comfort and energy efficiency 3.4 Integration of active and passive measures
Recommended time allocation	24 hours Classroom 12 hours Field trip 4 hours Spare time +8 hours Additional self-study
Learning outcomes	At the end of the module the learner is able to: ▪ Understand bioclimatic building design for Nigerian regions ▪ Apply passive architectural measures for comfort and energy efficiency ▪ Apply active measures of building services for comfort and energy efficiency ▪ Integrate passive and active measures of comfort and energy efficiency ▪ Apply design tools for simulation of bioclimatic performance and energy demand

Module 4. Energy supply *16 hours*

Content

4.1 Energy supply and demand
4.2 Renewable energies (RE) and combined cooling, heat and power (CCHP)

Recommended time allocation

14 hours	Classroom
2 hours	Spare time
+4 hours	Additional self-study

Learning outcomes

At the end of the module the learner is able to:

- Assess the availability of energy sources
- Integrate energy supply, especially renewable energy technologies, in the building design
- Apply simulation tools to assess energy supply and consumption, CO_2 emission and economic viability

Coursework: Building analysis and design *32 hours*

Content

A. Evaluate existing buildings (4 types) as to comfort and energy efficiency
B. Energy efficiency building design

Recommended time allocation

32 hours	Classroom
24 hours	Additional self-study

Learning outcomes

At the end of the module the learner is able to:

- Design an energy efficient building using established techniques and principles
- Use established techniques and principles to improve the energy performance of buildings in retrofits
- Participate in an integrated approach to design energy efficient buildings
- Apply software tools in the design of energy efficient buildings to simulate comfort and energy performance

Practice Test – In preparation of national certification *16 hours*

Purpose

At the end of the course, the aptitude of each trainee should be assessed through a practice test in preparation of National Certification. The test should be based on the same benchmark: **Nigerian Competency Standards for Clean Energy** | Release 2016 in the domain "Energy Efficient Building Designing".

Recommended duration and weightage

Duration	Examination type	Weightage
2 hours	Written examination	30%
14 hours	Oral exam / Project design	70%

Grading

A candidate is deemed to have completed the course successfully (passed) if candidates attains a cumulative average **score of 70% or above**.

Recommended certificate

Certificate of participation

MODULE 1: INTRODUCTION TO BUILDING PHYSICS

Content	Topics	Methods & materials	Key resources
1.1 Application of thermodynamics in building science (2 hours classroom)			Competency level: To understand
Building physics	- Definition of building physics - Application of thermodynamics in building performance	**Methods** Instruction, Discussion, Group work. **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards. **Activities** Exercise 1.1-1: Students are grouped to identify areas of building physics in building performance (e.g. transport of heat and matter, acoustics, lighting, fire protection etc.). Exercise 1.1-2: The class calculates the U-value of a given building component. Interactive session 1.1-1: Students propose physical effects related to building energy efficiency Interactive session 1.1-2: The teacher draws a schematic building on the board, and discusses with the students on energy gains and losses. Interactive session 1.1-3: The teacher separates the class in groups, with the task of finding and describing the main thermal bridges in the classroom with its building components. Interactive session 1.1-4: The group discusses about the thermal properties (conductivity and resistance) of different materials.	1. *Manual of tropical housing and building, part one: Climatic design* • O. Koenigsberger, et al.
The thermal and moisture performance of the building envelope	- Building regulations for energy efficiency - Certifications, labels		

Content	Topics	Methods & materials	Key resources
1.2 Energy balance of buildings (6 hours classroom + 1 hour additional self-study)			Competency level: To use
Equation of building energy balance	- External and internal heat gains	**Methods** Instruction, Discussion, Group work, Additional self-study. **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards. **Activities** Interactive session 1.2-1: Students identify different gains and losses and the need of mechanical thermal control. Demo 1.2-1: Teacher introduces calculation methods for heat gains and losses. Exercise 1.2-1: Students are divided into groups and are asked to calculate heat gains and losses for a given building.	1. *Building science for building enclosures* • J.F. Straube, E.F.P. Burnet. 2. *Manual of tropical housing and building, part one: Climatic design* • O. Koenigsberger, et al.
Identification of different heat gains and cooling load: Terms, SI units, magnitudes	- Internal heat gains - Solar heat gains - Conduction and superficial convection heat gains - U-value or thermal transmittance - Thermal bridges: linear transmittance - Thermal resistance - Thermal conductivity - Ventilation heat gains and losses		
1.3 Glossary of building physics (+1 hour additional self-study)			Competency level: To apply
Essential elements of thermodynamics	- Specific heat - Thermal capacity - Thermal lag - Solar heat gain coefficient of glass (g-value) - Relative humidity and dew point	**Methods** Instruction, self-study **Materials** Laptop, Projector **Activities** Demo 1.3-1: Teacher gives hint to glossary and literature.	1. *Manual of tropical housing and building, part one: Climatic design* • O. Koenigsberger, et al.

MODULE 2: DESIGN STRATEGY, TASK, CLIMATE AND BOUNDARY CONDITIONS

Content	Topics	Methods & materials	Key resources
2.1 Objectives of energy efficient building design (2 hours classroom)			Competency level: To understand
Effect of building energy consumption on global warming	- Definition - Greenhouse gas emissions - CO_2 footprint of buildings	**Methods** Instruction, Discussion, Group work **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards, projector **Activities** Exercise 2.1-1: Students are grouped and asked to define requirements of comfort for different building types. Interactive session 2.1-1: Students propose measures against global warming in the building sector of Nigeria. Interactive session 2.1-2: The group discusses about design and project strategies in Nigeria, and proposes possible improvements. ⌘Video 2.1-1: Trailer of "An inconvenient truth" D. Guggenheim, Al Gore. Site visit 2.1-1: The trainees visit an energy efficient building (e.g. PrimeTech Design Head Office in Abuja).	1. ♦ *Building Energy Efficiencycy Guideline for Nigeria. Federal Ministry of Power, Works and Housing (FMPWH)* • German Technical Cooperation (GTZ) 2. *The environmental design pocketbook* • S. Pelsmakers 3. *ANSI/ASHRAE standard 55, thermal environmental conditions for human occupancy.* 4. ♦*Energy efficiency requirements in building codes, energy efficiency policies for new buildings* • J. Lausten 5. ♦*The key to energy efficiency in buildings* • ASHARE
Standards, requirements, labels	- Building regulations for energy efficiency - Certifications, labels		
Comfort and energy efficiency	- Thermal comfort - Visual comfort - Air quality		
2.2 Integrated design strategies (4 hours classroom)			Competency level: To use
Integrated design process	- Strategies - Project preparation - Concept design - Detailed design - Construction - Monitoring	**Methods** Instruction, Discussion. **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards.	1. *RIBA plan of work 2013 guide* • RIBA publishing 2. *The environmental design pocketbook* • S. Pelsmakers

Content	Topics	Methods & materials	Key resources
Design tools	- BIM software - Lighting design	**Activities** Demo 2.2-1: Teacher demonstrates how to use a design tool, e.g. thermal simulation, solar path diagram Exercise 2.2-1: Students are divided into groups and are asked to develop workflow with professions for energy efficient building design process. Interactive session 2.2-1: Students discuss their experiences with design tools and explain strengths and weaknesses.	
2.3 Climate, microclimate, urban design (2 hours classroom)			Competency level: To apply
Climate	- Climate zones - Elements of climate - ASHARE definitions - Sources of climate data	**Methods** Instruction, Discussion **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards, climate data from internet. **Activities** Demo 2.3-1: Teacher demonstrates how to access climate data of Nigeria in internet (thermal simulation programme or using www.nimet.gov.ng Demo 2.3-2: Teacher introduces and demonstrates to the class the simulation programme for urban design ENVI-MET BASIC	1. ♦*ENVI-MET scientific experience builds residential cities* • www.envi-met.com/#section/intro 2. ♦*Urban heat island and bio-climatological conditions in a hot-humid tropical city: The example of Akure, Nigeria* • I.A. Balogun, A.A. Balogun.
Microclimate and urban design	- Strategies to minimise urban heat islands		

MODULE 3: PASSIVE AND ACTIVE MEANS FOR ENERGY EFFICIENT DESIGN

Content	Topics	Methods & materials	Key resources
3.1 Bioclimatic building design (4 hours classroom + 8 hours site visit)			Competency level: To apply
Climate zones of Nigeria	- Monsoon climate - Tropical savanna climate - Warm semi-arid and desert climate (Sahel) - Factors affecting climate	**Methods** Instruction, Discussion, Field trips and study tours **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards. **Activities** Demo 3.1-1: Teacher demonstrates how to analyse a building as to comfort and energy efficiency. Exercise 3.1-1: Students are divided into groups and are requested to collect and present climate data for different locations. Interactive session 3.1-1: The group discusses about design and project strategies in Nigeria, and proposes possible improvements. Interactive session 3.1-2: The students discuss about the vernacular building traditions in their regions of origin, finding the sustainable solutions and their motives. Site visits 3.1-1: Students are divided into groups and asked to analyse buildings as to comfort and energy efficiency and present results (4 site visits) ▪ Residential best practice ▪ Residential energy efficient ▪ Office best practice ▪ Office energy efficient.	1. ♦*Building Energy Efficiency Guideline for Nigeria. Federal Ministry of Power, Works and Housing (FMPWH)* • German Technical Cooperation (GTZ) 2. *Building to Suit the Climate* • G. Hausladen, et al.
Vernacular Nigerian architecture	- Influence of climate - Other influences - Integrating traditional technologies in contemporary architecture		
Bioclimatic design approaches	- Main principles - Strategies - Passive measures of comfort - Active measures of comfort		
Contemporary architecture	- 20th century architecture - High-trop and low-trop - Today: best practices		

3.2 Passive measures for energy efficient design (10 hours classroom)			Competency level: To apply
Solar control, cool materials	- Task - Principal solutions - Shading devices - Solar control glazing - Characteristics of solar control - Solar reflectivity of materials	**Methods** Instruction, Discussion **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards, Thermal and lighting simulation software, Local climate data. **Activities** Demo 3.2-1: Teacher demonstrates thermal simulation with parameter variation for window orientation, solar control, ventilation, insulation, thermal capacity. Demo 3.2-2: Teacher demonstrates daylighting simulation with parameter variation. Demo 3.2-3: Calculation of embodied energy for a building design with parameter variation of construction / material. Exercise 3.2-1: Students carry out thermal simulation for window orientation, solar control, ventilation, insulation, thermal capacity. Exercise 3.2-2: Students carry out daylighting simulation. Exercise 3.2-3: Students Calculate embodied energy of a building design with parameter variation of construction / material.	1. *Energy performance of buildings* • B. Sofia-Natalia, et al. 2. *Energy manual: Sustainable architecture* • M. Hegger et al. 3. *Climate design: Solutions for buildings that can do more with less technology* • G. Hausladen et al. 4. *The environmental design pocketbook* • S. Pelsmakers
Natural ventilation	- Tasks - Physical effects of ventilation - Design hints for natural ventilation		
Insulation, thermal capacity	- Tasks - Thermal insulation - Insulation materials		
Day lighting	- Task - Characteristics and availability of daylight - Design principles - Solar control geostructural features		
Embodied energy of materials	- Overall energy balance - Hints for material selection		

3.3 Active measures for energy efficient design (10 hours classroom)			Competency level: To apply
Mechanical ventilation	- Functions of ventilation - Air conduction in rooms	**Methods** Instruction, Discussion	1. *Plusminus20°/40° latitude. Sustainable building design in tropical and subtropical regions*

Content	Topics	Methods & materials	Key resources
	- Air conduction in buildings	**Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards, Thermal and lighting simulation software. **Activities** Demo 3.3-1: Teacher demonstrates lighting simulation with parameter variation of artificial light source and control. Demo 3.3-2: Teacher demonstrates thermal simulation with parameter variation of mechanical ventilation, cooling, air conditioning. Demo 3.3-3: Teacher demonstrates the simulation for optimized overall energy consumption for integration of active and passive means. Exercise 3.3-1: Lighting simulation with parameter variation of artificial light source and control. Exercise 3.3-2: Thermal simulation with parameter variation of mechanical ventilation, cooling, air conditioning. Exercise 3.3-3: Simulation for optimized overall energy consumption for integration of active and passive means.	• D. Hindrichs, K. Daniels. 2. *Energy performance of buildings* • B. Sofia-Natalia, et al. 3. *Climate design: Solutions for buildings that can do more with less technology* • G. Hausladen et al. 4. *ASHRAE handbook - HVAC Ventilation of Buildings* • A. Hazim. 5. *Aktivhaus - The reference work from passivhaus to energy-plus house* • M. Hegger, et al. 6. ♦*Technology roadmap; energy-efficient buildings: Heating and cooling equipment* • OECD/IEA
Low energy cooling, air conditioning	- Approaches of cooling - Water and air operated systems - Cold generation		
Artificial lighting	- Requirements of visual performance - Light sources - Luminaires and rooms		
Building automation systems (BAS)	- Objectives of BAS - Network and structure - Application		

Content	Topics	Methods & materials	Key resources
3.4 Integration of active and passive measures (4 hours classroom)			Competency level: To apply
Integration of Active and Passive Measures	- Recommendations of combined measures of climate zones in Nigeria - Case studies - Central or distributed HVAC - Thermal activation of building elements	**Methods** Instruction, Discussion **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Meta-plan cards, Metaplan pin boards, Local climate data **Activities** ⌘Exercise 3.5-1: Students perform sizing calculations using Excel spreadsheet.	

MODULE 4: ENERGY SUPPLY

Content	Topics	Methods & materials	Key resources
4.1 Energy supply and demand (3 hours classroom)			Competency level: To understand
Typical energy demands	- Groups of energy consumers - Building types	**Methods** Instruction, Discussion **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards, Thermal and lighting simulation software. **Activities** Demo 4.1-1: Teacher demonstrates variation of energy demand for exemplary buildings. Exercise 4.1-1: Variation of energy demand for exemplary buildings.	1. *The environmental design pocketbook* • S. Pelsmakers 2. *The passivhaus designer´s manual. A technical guide to low and zero energy buildings* • C.J. Hopfe, R.S. McLeod
Efficient and sustainable supply of energy	- Assessment by primary energy or CO_2 intensity - Public supply and micro-grids - Supply security and back-up systems		
4.2 Renewable energy and combined cooling, heat and power (11 hours classroom)			Competency level: To apply
Availability and decision making	- Local resources	**Methods** Instruction, Discussion **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards, Thermal and lighting simulation software. **Activities** Exercise 4.2-1: Simulation of primary energy demand and CO_2 emission for parameter variation of energy supply/renewable energy for exemplary buildings. Exercise 4.2-2: The groups make a rough assessment of the energy demand of buildings: ▪ Small and large residential ▪ Small and large office ▪ Small and large school. Exercise 4.2-3: The groups develop different ways of energy supply for the considered building, with either fossil or renewable energy.	1. *Aktivhaus - The reference work from passivhaus to energy-plus house* • M. Hegger, et al. 2. *Climate design: Solutions for buildings that can do more with less technology* • G. Hausladen et al. 3. ♦*Battery storage for renewables: Market status and technology report* • IRENA
Solar photovoltaics (PV)	- Types of PV cells - Building integration of PV - Energy yield of PV Storage of PV generated electricity		
Solar thermal systems	- Type of collector - Heat storage - Dimensioning		
Biomass	- Forms of utilisation - Biogas plant		
Combined cooling, heat and power (CCHP)	- Trigeneration Process - Small and micro CCHP		

Content	Topics	Methods & materials	Key resources
		⌘Video 4.2-2: Living off the grid of Nigeria. HBSNigeria Boell.	

COURSEWORK: BUILDING ANALYSIS AND DESIGN

Content	Topics	Methods & materials	Key resources
A. Building evaluation (16 hours classroom + 12 hours additional self-study)			Competency level: To apply
Note: The coursework is deliberately not covered by the handbook. It is designed to be carried out with data of the local context.			
Data collection for existing buildings (utilization of module 3.1 results)	- Building type - Building design - Construction, materials - Ventilation, cooling, lighting, hot water - Comfort measurements - Energy supply, consumption	**Methods** Instruction, Discussion, Group work **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards, 4 different building types, Results of Module 3.1 **Activities** Exercise 5.1-1: Design of a new sustainable building using the passive and active measures and all the strategies explained during the course. An exhibition follows where each group presents its concept and drawings.	1. ♦*Building Energy Efficiency Guideline for Nigeria. Federal Ministry of Power, Works and Housing (FMPWH)* • German Technical Cooperation (GTZ) 2. *ANSI/ASHRAE standard 55, thermal environmental conditions for human occupancy.*
Evaluation of existing situation and proposals for refurbishment, documentation	- Plans, sections, elevations, details - Specification of construction, materials, services - Measurement results - Modelling of comfort and energy demand - Proposals for improved comfort and energy efficiency		
B. Energy efficient building design (16 hours classroom + 12 hours additional self-study)			Competency level: To accomplish
Note: The coursework is deliberately not covered by the handbook. It is designed to be carried out with data of the local context.			
Design task, basic evaluation	- Realistic plot, boundary conditions - Building type, size - Comfort requirements - Maximum energy demand	**Methods** Instruction, Discussion, Group work **Materials** Laptop, Projector, Speakers, Whiteboard, Markers, Metaplan cards, Metaplan pin boards, CAD and simulation software, access to climate data	1. ♦*Building Energy Efficiency Guideline for Nigeria. Federal Ministry of Power, Works and Housing (FMPWH)* • German Technical Cooperation (GTZ) (Especially chapter 12 case study).
Sketch design and energy concepts	- Bioclimatic design (variations) - Integration of passive and active		

Content	Topics	Methods & materials	Key resources
	measures - Energy supply simulation of comfort and energy demand	**Activities** Role play 5.2-1: Integrated design process (4 groups/teams, each with client, architect, and experts for passive and active measures of energy efficient building design). ⌘Exercise 5.2-1: Energy efficient building design for 2 projects (housing, office) and 2 competitive teams for each project, using handbook information and simulation tools. Exercise 5.2-1: Groups present design results and the students themselves agree on the best solution.	
Assessment, decision making and design documentation	- Assessment of design variations - Decision for most energy efficient solution - Design documentation		

FURTHER SUGGESTIONS

- Combine the coursework with realistic housing or office projects.