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| Didactic Guide  Efficient energy use and thermal optimization in buildings |
| *SIDS DOCK in cooperation with PCREEE, CCREEE and ECREEE.*  *Developed with key technical support of UNIDO and CIEMAT.*  *With the financial support of AECID and ADA.* |

# Didactic Guide

## Efficient energy use and thermal optimization in buildings

## OBJECTIVES

### General Objective

### The objective of this module is to provide essential knowledge of the key concepts to analyse buildings on an energy basis, incorporating to the student’s knowledge the techniques and concepts of energy efficient in buildings. The module includes not only the energetic aspects of the architectonic design, but also the integration of active solar systems for heating and cooling.

### Specific Objectives

* To understand the main concepts of energy efficiency in building, the influence of boundary variables such as solar radiation in the emplacement as well as the importance of considering the different climates existing in island countries and territories of the Pacific, Caribbean an West Africa oceans
* To present the basis of the natural thermal conditioning’s techniques (solar chimneys, direct and indirect solar gains, shading, thermal inertia, natural ventilation) and the direct application on heating and cooling strategies that can be applied taking into account the different geographical and climatic zones in Islands and Territories in the target regions.
* To apply these skills and knowledge through the adequate methodology and existing software for energetic analysis of buildings.
* To develop advanced skills and competency in building integration’s designs of active solar systems, and apply this concepts to the optimization of these systems when applied to DHC.
* To provide the correct methodology for development of energy efficiency in buildings projects; apply these concepts on a case study.
* COURSE STRUCTURE

Efficiency energy use and thermal optimization in builidings

Objectives of the Module

1. Why energy efficiency in buildings

Introduction

Why energy efficiency in buildings

Passive solar gains

The importance of the design from an energetic point of view

Thermal comfort and energy savings: differences

Conclusions

2. Fundamentals of thermal conditioning of buildings

Introduction to the thermal and conditioning

Surrounding climate

Solar radiation

Sun path

Distribution spectral-spatial of the radiation

Solar irradiancy over an arbitrary surface

Long wave radiation

Psychometric state of the atmosphere

Air composition. Dry and humid air

Variables that define the psychometric state of the atmosphere

Psychometric chart

Ground thermal state

Wind

Energetic transference in buildings

Conduction

Convection

Radiation

Mass Transfer

Energy balance of a building

Thermal comfort

Energetic transference on thermal comfort

Global thermal comfort estimation. Pmv and ppd

Conclusions

3. Natural techniques of thermal conditioning in buildings

Introduction

The issue of passive design

Main factors of an energy efficient design

Applications of solar passive energy

Heating

Cooling

Natural lighting

Heating natural techniques

Orientation

Walls and hollows according to orientation

Thermal inertia

Solar Gain

Natural cooling techniques

Solar control

Ventilation

Actives techniques of thermal conditioning

Evaporative techniques

Buried pipes

Radiant systems

Conclusions

4. Theoretical energy study: simulation

Theoretical energetic evaluation

Methods of energetic simulation

Methodology of the process of energetic simulation

Conclusions

5. Energetic evaluation of buildings under real conditions of use. Monitoring

Methodology of monitoring

Preview knowledge

Design and experimental execution.

Analysis of the experimental data

Models for analytic study

Static models

Dynamic models

Conclusions

6. Integration of active solar systems in buildings

Introduction

Environment

Building

PV modules

Solar thermal collectors

Influence over the comfort of the integration of the active solar systems

Most used solar thermal applications in buildings

Domestic hot water

Heating

Pools heating

Solar cooling

Conclusions

## CONCEPTUAL MAP

Concept map-12

## PLAN OF ACTIVITIES

The study of this course requires reading and understanding of the theoretical concepts, which you will find in the documentation of the module. The content of this study covers the areas of the course activities which will be evaluated at the end of this module. These activities are the following:

* Displaying the multimedia content and conduct of the assessment test type associated with it. This test will consist of 5 multiple choice questions. There are 2 attempts to do so.

To pass this activity the participant must achieve 80% correct answers (4 correct answers).

* Read the documentation. In the first place, the main text of the module has to be read. Later on, the student should check the bibliography to get a further understanding of the different concepts and in order to have an overview of all the data and information that is being addressed in each chapter.
* Case study: is designed to learn how to make a first approach to energy-efficient design of a building. This practical case is divided in two phases carried out with two different simulation programs. The first phase tries to identify the best bioclimatic strategies adapted to the selected climatic zone. This identification is going to be done with a Givoni chart that highlights different passive and active techniques which can be later studied by means of energy simulation programs. The second phase analyses the thermal loads of one building model modifying different bioclimatic strategies through a simulation program. With this work it is expected that the students acquire the conceptual importance of design in terms of climate and place, thus invalidating the repetitive designs that don’t take into account the emplacement of the building.

A short self-assessment test will be presented to evaluate the knowledge and understanding of the practical case approach and performance. For each question there will be several possible answers and only one correct. There are 5 attempts to perform the test. To overcome this activity the participant must have 100% of the correct answers.

### Final self-assessment test, through which it can be checked the level of conceptual understanding of the module, and it can be used as a reference of these aspects that deserved a further analysis by the student

### This test will present 20 questions with several possible answers and only one correct. You have 1 hour and 2 attempts to perform it. To pass this activity the participant should reach 80% of correct answers (16 correct answers).

### To properly complete the course, the estimated time commitment is 20 hours distributed as is most convenient for each participant. Being a self-training mode is allowed flexibility in the implementation of activities, although we recommend regularly in the course, spending one to two hours daily, to the best use.

All those activities with more than one attempt for implementation, will consider the highest score to reach the final result.

## DIPLOMA

Upon graduation UNIDO, CIEMAT and ECREEE will issue a certificate of achievement for participants who exceed the following requirements:

* View 100% of the content and achieve 80% of the assessment test associated with it.
* Perform the case study and correctly answer to 100% of the questions associated with it
* Overcoming 80% of the final self-assessment test.

Once achieved these requirements, the participant may access the appropriate section in the virtual classroom and download the diploma in electronic format.