3encult

EFFICIENT ENERGY FOR EU CULTURAL HERITAGE

D 8.9 Education Material for University Studies

EUROPEAN COMMISSION

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Theme [EeB.ENV.2010.3.2.4-1]

[Compatible solutions for improving the energy efficiency of historic buildings in urban areas]

Collaborative Project – GRANT AGREEMENT No. 260162

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Table of Content

0 Abstract

The document collects the material developed for a university training package with different modules. The lessons were developed in ongoing courses realized in European and International Universities by the various partners involved in this work. In particular, the 3encult partners involved are:

- Accademia Europea per la Ricerca Applicata ed il Perfezionamento Professionale Bolzano (Accademia Europea Bolzano) (Eurac);
- Universitaet Innsbruck (UIBK);
- Fundacion Cartif (CARTIF);
- Alma Mater Studiorum - Università degli Studi di Bologna (UNIBO);
- Technische Universitaet Dresden (TUD);
- Bartenbach Lichtlabor Gmbh (BLL).

The lessons were developed in university courses already provided in the training programs at degree, masters and continuous education levels. In particular, the lessons were carried out in the following courses:

- TIS Innovation School of Bolzano (UNIBO);
- Advanced school on ICT for future energy systems realised at Università di Trento (UNIBO);
- "Masterstudium Domotronik" realized at University of Innsbruck (UIBK);
- Darmstadt Engineering Congress - Civil and Environmental Engineering realised at Technische Universität Darmstadt, Fachbereich Bauingenieurwesen und Geodäsie (EURAC);
- Master course “Preservation and urban development” realised at Technische Universitaet Dresden (TUD);
- Lighting Academy of University of Innsbruck (BLL);
- Master of Research in Architecture realized at University of Valladolid, School of Architecture (CARTIF);
- Master in Industrial Energy Management realized at Metropolitan Technology Institute, Medellín (Colombia) (CARTIF).

Here are discussed the subsequent themes:

- Environmental monitoring;
- Energy efficient solutions for sustainable renovations, particularly related to natural ventilation, windows replacement, internal insulation, damages caused by ;
- Daylight and artificial lighting;
- Methodology for energy retrofitting: diagnosis procedures.

Furthermore, various thesis are presented. The thesis have been discussed during 3encult project at the Technische Universitaet Dresden (TUD) and Technische Universitaet Sttutgart (UDTUTT). They regarded the 3encul case studies and focused on the issues of monitoring, energy efficiency and energy retrofits of historic buildings.

1 Indoor Environment monitoring

Presentation 1

Author: Giacomo Paci

Partner: Università degli Studi di Bologna, Dipartimento DEIS (UNIBO)

University course: TIS Innovation School

Date: 2012/07/23

Place: TIS, Bolzano

Title of the lesson: Monitoring and control: Technology and methodology approach

Description of the contents: The lesson regards the monitoring and control concept and in particularly the development of sensors, sensor interfacing, data acquisition and transmission.

Network infrastructure and protocol

Name of the file: WP8_D8.9_20131007_UNIBO-Presentation 1

Presentation 2

Author: Giacomo Paci

Partner: Università degli Studi di Bologna, Dipartimento DEIS (UNIBO)

University course: Advanced school on ICT for future energy systems

Date: 2012/09/13

Place: Università degli Studi di Trento

Title of the lesson: Densely Instrumented Physical Infrastructures for Energy-Efficient Building

Description of the contents: The lesson regards the basic concept of energy savings of historic building and living comfort, with a particular attention of monitoring instrument and control concept.

Name of the file: WP8_D8.9_20131007_UNIBO-Presentation 2

2 Energy Efficient Solutions for Sustainable Renovations

Presentation 1

Author: Rainer Pfluger, Gerald Gaigg, Kai Längle

Partner: University of Innsbruck (UIBK)

University course: Nachhaltige Gebäudesanierung ("Sustainable Renovation" for Students in "Masterstudium Domotronik")

Date: 16.01.2013

Place: Innsbruck, University of Innsbruck, SR-Container 5

Title of the lesson: “Sustainable Renovation of Buildings - Lessons learnt from 3ENCULT-Case Study CS5”

Description of the contents: Within the university course "Sustainable renovation", students learn refurbishing strategies and how to include energy efficiency. The course "Nachhaltige Gebäudesanierung" is about refurbishing in general (not only on listed buildings and cultural heritage), however the training material elaborated within 3ENCULT has it's special focus on that. The content includes some introduction in terms of basic building physical issues as well as the principles of conservation. The school building CS5 (NMS Hötting) was used to demonstrate how to find well adapted solutions for a specific building, based on detailed building diagnosis and measuring results for comfort and air quality parameters.

Name of the file: WP8_D8.9_20131007_UIBK-Presentation 1

Presentation 2

Author: Alexandra Troi

Partner: EURAC research (EURAC)

University course: Darmstädter Ingenieurkongress - Bau und Umwelt

Date: 12-13.03.2013

Place: Technische Universität Darmstadt, Fachbereich Bauingenieurwesen und Geodäsie

Title of the lesson: “Innovative Konzepte der energetischen Sanierung im Baudenkmal“

Description of the contents: The energy requirement of a historic building can be substantially reduced finding the right solutions and implementing the high quality. This is the guiding principle in the European research project 3ENCULT "Efficient Energy for EU Cultural Heritage": for the energy retrofit of a historic building the multidisciplinary exchange between all stakeholders starts with a comprehensive diagnosis of the status quo, supports the development of solutions and selection of the most appropriate one, and does not end before an integrated monitoring and control, which verifies and guarantees performance. Methods to be applied include (i) conservation inventory system (as e.g. “Raumbuch”) which are further developed in order to well interface with energy issues, but also (ii) conservation related non or minor destructive testing (NDT) technologies (as e.g. IR-thermography, ground penetrating radar, ultrasonic tests) as well as (iii) energy performance related diagnosis (as e.g. again IR-thermography, blower door test, heat flow measurements). Also, the works work done in the Waaghaus in Bozen and in the Höttinger Schule in Innsbruck are presented. The works regard internal insulation, replacement of windows, air tightness, moisture at beam ends, ventilation, air flow balancing, daylight and artificial lighting optimisation.

Name of the files: WP8_D8.9_20131007_EURAC-Lesson 1 en and WP8_D8.9_20131007_EURAC-Lesson 1 de

Presentation 3

Author: Rudolf Plagge

Partner: TU Dresden

University course: Altbausanierung, Hauptstudium (Refurbishment, post graduate)

Date: 15.04.2013 and 14.04.2014 (planned)

Place: Dresden, Bauphysikalisches Forschungs und Entwicklungslabor, Institut für Bauklimatik der TU Dresden

Title of the lesson: “Refurbishment - definition”

Description of the contents: The lesson regards a procedure for a procedure to understand if it is a historic building or not. Subsequently describes the evolution of construction techniques in the course of time as regards masonries, roofs, basement, ceilings and windows.

Name of the file: WP8_D8.9_20131007_TUD-Lessons 1

Presentation 4

Author: Rudolf Plagge

Partner: TU Dresden

University course: Altbausanierung, Hauptstudium (Refurbishment, post graduate)

Date: 22.04.2013 and 28.04.2014 (planned)

Place: Dresden, Bauphysikalisches Forschungs und Entwicklungslabor, Institut für Bauklimatik der TU Dresden

Title of the lesson: “Building surveying and diagnostics”

Description of the contents: the lesson explains a procedure to understand the conservative or damage conditions of a historic building through the use of various non destructive techniques (NDT), which include the geometric relive and the infrared thermography. It also described the damages that a building can undergo during time, going to investigate every building component.

Name of the files: WP8_D8.9_20131007_TUD-Lessons 2

Presentation 5

Author: Rudolf Plagge

Partner: TU Dresden

University course: Altbausanierung, Hauptstudium (Refurbishment, post graduate)

Date: 29.04.2013 and 05.05.2014 (planned)

Place: Dresden, Bauphysikalisches Forschungs und Entwicklungslabor, Institut für Bauklimatik der TU Dresden

Title of the lesson: “energy efficient renovation”

Description of the contents: To understand the behaviour of historic buildings is necessary to develop a deeper knowledge of the cultural heritage property. An accurate audit is the first step to identify the need for suitable intervention. The lesson define the procedure for a energy audit systematic procedure to obtain adequate knowledge of the energy consumption profile of a building or group of buildings, an activity and/or industrial facility or public or private services, to identify and quantify energy saving opportunities from a cost-effectiveness profile and to report the results.

Name of the file: WP8_D8.9_20131007_TUD-Lessons 3

Presentation 6

Author: Rudolf Plagge

Partner: TU Dresden

University course: Altbausanierung, Hauptstudium (Refurbishment, post graduate)

Date: 06.05.2013 and 12.05.2014 (planned)

Place: Dresden, Bauphysikalisches Forschungs und Entwicklungslabor, Institut für Bauklimatik der TU Dresden

Title of the lesson: “energy efficient renovation”

Description of the contents: The lesson describes in detail the techniques of internal insulation of walls, indicating advantages, disadvantages, potential problems, materials and tools used for the calculation and assessment. The, are presented examples of analysis of thermal bridges in the building.

Name of the file: WP8_D8.9_20131007_TUD-Lessons 4

Presentation 7

Author: Rudolf Plagge

Partner: TU Dresden

University course: Altbausanierung, Hauptstudium (Refurbishment, post graduate)

Date: 13.05.2013 and 19.05.2014 (planned)

Place: Dresden, Bauphysikalisches Forschungs und Entwicklungslabor, Institut für Bauklimatik der TU Dresden

Title of the lesson: “Protection of driving rain”

Description of the contents: the lesson describes the problems of deterioration of building caused by water in masonries, roofs and basement. Then are illustrated the intervention techniques to ensure sanitation. Are finally are described the laboratory test that can be used to investigate these issues.

Name of the file: WP8_D8.9_20131007_TUD-Lessons 5

Presentation 8

Author: Rudolf Plagge

Partner: TU Dresden

University course: Altbausanierung, Hauptstudium (Refurbishment, post graduate)

Date: 20.05.2013 and 26.05.2014 (planned)

Place: Dresden, Bauphysikalisches Forschungs und Entwicklungslabor, Institut für Bauklimatik der TU Dresden

Title of the lesson: “Moisture damage - mold”

Description of the contents: the lesson describes the degradation phenomena related to interstitial condensation, mold and biological germination.

Name of the file: WP8_D8.9_20131007_TUD-Lessons 6

Presentation 9

Author: Rudolf Plagge

Partner: TU Dresden

University course: Altbausanierung, Hauptstudium (Refurbishment, post graduate)

Date: 03.06.2013 and 02.06.2014 (planned)

Place: Dresden, Bauphysikalisches Forschungs und Entwicklungslabor, Institut für Bauklimatik der TU Dresden

Title of the lesson: “windows, basement,”

Description of the contents: The lesson describes how to analyze a historic windows and then the techniques and the methods for the energy retrofit.

Name of the file: WP8_D8.9_20131007_TUD-Lessons 7

3 Daylight

Presentation 1

Author: Robert Weitlaner

Partner: Bartenbach Lichtlabor

University course: The lesson could be realized on University Courses on light (i.e. Faculty of Architecture) and also on Bartenbach Lighting Academy

Date: 24.01.2013, University Innsbruck, course: ‚Projektmanagement und interdisziplinäres Planen 2', Fakultät für Architektur, Fakultät für Bauingenieurwesen, lecturer: Robert Weitlaner, audience: students of architecture and civil engineering.

Future integration in Bartenbach Lighting Academy.

Place: Aldrans

Title of the lesson: Grundlagen der Tagesbelichtung in historischen Gebäuden – Lösungsansätze: Daylighting in historic buildings: approach and solution

Description of the contents: Principle question to be considered when the task of 'Daylighting in historic building' is commissioned. Showing an assessment approach, key questions and key answers. Case study examples show specific solutions.

Name of the file: WP8_D8.9_20131007_BLL-Lesson 1

4 Methodology for energy retrofitting: diagnosis procedures

Presentation 1

Author: Miguel Á. García-Fuentes

Partner: CARTIF

University course: Master of Research in Architecture

Date: 04.03.2013 and 21.11.2013

Place: University of Valladolid, School of Architecture

Title of the lesson: “Methodology for energy retrofitting in historic buildings” (translation)

Description of the contents: The lesson describes the methodology developed in the framework of the 3encult project for the diagnosis and evaluation of interventions in historic buildings, combining tools of building energy performance simulation, monitoring techniques and non-destructive testing in buildings. Especially relevance had the Blower Door Test carried out in the School of Engineers in Béjar, performed by the Ventilation Research Laboratory of the School of Architecture of Valladolid.

Name of the file: WP8_D8.9_20130304_CARTIF-Lesson1

Presentation 2

Author: Miguel Á. García-Fuentes

Partner: CARTIF

University course: Master in Industrial Energy Management

Date: 23.11.2013

Place: Metropolitan Technology Institute, Medellín (Colombia)

Title of the lesson: “Building Energy Performance Simulation” (translation)

Description of the contents: The lesson was focused on Building and Facilities Energy Performance, covering an introduction about the Energy Performance principles and simulation tools, and then focusing two projects: 3encult and BaaS (Building as a Service) (the slides corresponding this last project has been removed). The lesson was made via teleconference, and the attendees were very interested about the simulation processes and the non-destructive testing deployed in the building.

Name of the file: WP8_D8.9_201311_CARTIF-Lesson2

5 Thesis

Thesis 1

Faculty: Fakultät Architektur Instituts für Bauklimatik

Title: Evaluation of different calculation approaches for energy balances of an existing historical example building

Author: Mandy Drechsel

Relator: Ayman Bishara

Type of thesis: Degree Thesis

Name of the file: WP8_D8.9_20131007_TUD-Thesis 1 and Diplomarbeit_Mandy Drechsel

Thesis 2

Faculty: Fakultät Architektur Instituts für Bauklimatik

Title: Evaluation of different calculation methods for thermal bridges of an existing historical example building

Author: Mareike Czaska

Relator: Ayman Bishara

Type of thesis: Degree Thesis

Name of the file: WP8_D8.9_20131007_TUD-Thesis 2

Thesis 3

Faculty: Technische Universität Darmstadt i Institut für Massivbau Masterarbeit M04/2012 Fachgebiet Werkstoffe im Bauwesen

Title: Energetic retrofit of a historic log house on the example of a „Strickbau“

Author: Florian Schweikert

Relator: Harald Garrecht

Type of thesis: Master Thesis

Name of the file: WP8_D8.9_20131007_USTUTT-Thesis 3