SouthZEB WP3-Task2: Deliverable D3.2: SouthZEB Training Modules

Prepared for:
Project Officer
EASME

Co-funded by the Intelligent Energy Europe Programme of the European Union

March 2017

Client report number
Deliverable D3.2

Co-funded by the Intelligent Energy Europe Programme of the European Union

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1 INTRODUCTION

The recast Directive on the energy performance of buildings (EPBD) stipulates that all new buildings constructed within the EU after 2020 should reach nearly zero energy level, and following 31st December 2018 new buildings occupied and owned by public authorities are nearly zero energy buildings. Technically, every architect should be able to design a nearly zero energy building (nZEB), however, in practice this requires ongoing awareness of technical standards and innovative practice. On-going training programmes can help overcome this potential barrier.

As such, the objective of the SouthZEB project is to design and develop training and assessment programmes for the abovementioned professionals, focussing especially on the transfer of successful practices and knowledge from the front runner countries (i.e. UK, Austria, Germany, and France) to the south EU countries.

The modules will be based on recognised and successful professional development courses and will be adapted to the participating countries' specific needs and regulations. Special emphasis will be paid to the building traditions of participating countries. Training modules will also be developed for construction management and field supervision of nZEB as well as for training the decision makers in the preparation of appropriate funding schemes and other incentives for promoting nZEB. Best practice examples from successful programs in the most advanced (in this area) EU countries will be used in the training programs.

The objectives of the project include the following:

- At least 150 trainers will be trained to deliver the modules
- At least 1,500 professionals (engineers, architects, municipality employees, decision makers) will be trained on nZEB
- At least 400 professionals trained remotely through the e-learning platform (part of the 1,500 stated above)
- At least 3,000 user registrations in the portal by the end of the project
- Four new funding and promotion schemes for nZEB designed, one in each of the South European participating countries (i.e. Greece, Cyprus, Portugal and south Italy).

A total of ten training modules have been developed from the SouthZEB project. Ten assessment exams, one for each of the training modules, has also been created.

Detailed descriptions of each of the ten modules are appended to this report as follows:

- Appendix A – description of Module 1: Basic module
- Appendix B – description of Module 2: Advanced module
- Appendix C – description of Module 3: Building thermal performance
- Appendix D – description of Module 4: Thermal comfort
- Appendix E – description of Module 5: Local Architectural Regulations & Certification Framework
- Appendix F – description of Module 6: NZEB Simulation & Design Software
- Appendix G – description of Module 7: Low Carbon Technologies & Automation
- Appendix H – description of Module 8: Retrofitting
- Appendix I – description of Module 9: Construction Management & Field Supervision
- Appendix J – description of Module 10: Funding & Incentives

APPENDIX A - DESCRIPTION OF MODULE 1: BASIC MODULE

2 WP3 – TASK 2 - TRAINING MODULE 1 – BASIC MODULE DESCRIPTION

2.1 Preparation and delivery

Preparation of the course material is undertaken by CUT with close collaboration with the rest of the consortium (in accordance with the Description of Work). Nevertheless, CUT is responsible for the development of all sessions of module 1. The Exams are prepared by KEK.

The individual responsible is Dr. Polyvios Eleftheriou an Assistant Professor of CUT. Dr. Eleftheriou has been teaching basic and advanced thermodynamics, thermal and acoustic performance of buildings, HVAC systems, thermal losses in buildings and building energy modelling for more than 25 years of activity at the Cyprus University of Technology (since its founding in 2004) and Cyprus Higher Institute of Technology since 1988, where he has delivered undergraduate and postgraduate courses as well as scientific presentations. He will be assisted as required by Flouris Xeni a PhD student. Assistant Professor Eleftheriou will also be responsible for the quality check of the material.

Local issues are determined and course material is prepared by the local partners in the target countries. Every effort should be made so content should not exceed 20% of the total course material. The local issues are prepared by local partners, CUT and GARnet in Cyprus, KEK and UPatras in Greece, DTTN in Italy and UMinho and IST-ID in Portugal.

Delivery of the training course material to trainers is undertaken in each country by the relevant partners (in accordance with the Description of Work); in Cyprus by CUT, in Greece by KEK (Euro Training), in Italy by DTTN and in Portugal by UMINHO and IST-ID. Later, the trainers will also deliver the courses to the trainees.

2.2 Outline of Module 1 – Basic Module

“Module 1” aims at presenting to engineers, architects, building supervisors, site managers, building auditors, government and local authorities officials involved in the regulation of energy efficiency in buildings the basic concepts and definitions of buildings, building envelope, electrical, mechanical and HVAC systems employed in buildings, as well as, the methodology on the energy assessment of buildings and the key parameters and minimum requirements leading to the certification of a near Zero Energy Buildings (nZEB).

Since the Basic Module and its material is intended for addressing engineers of multi-disciplinary background (architects, civil engineers, mechanical engineers, electrical engineers, etc.) and experience (from young graduates to highly experienced) professionals, it is structured in such a way in order to provide an introduction to basic legislation and concepts followed by a smooth transition to more advanced issues leading to a near Zero Energy Building construction.

Initially the module material focuses on the related European Directives (EPBD recast and RED) and the local legislation and regulations, which are now the driving forces towards the 2019 and 2021 milestones for near Zero Energy Buildings. A section related to the building envelope follows, presenting the basic

concepts and structures (walls, floors, roofs, windows, etc.) and thermal losses mechanisms. Then comes a chapter dedicated to thermal insulating materials (from most commonly used in the present to state of the art and materials of the future) followed by a section on HVAC systems which are considered of great importance in southern climates. Finally a practical example is presented on the design of a residential near Zero Energy Building.

The estimated duration of the training is 20 hours, divided in pre-course preparation, classroom, post-course study and finally an exam.

This training module is coordinated, designed and planned by CUT, with the collaboration of partners from each target country (Cyprus, Greece, Italy and Portugal) for the development of the specific training material related to local issues and particularities. As a result, the approach changes among countries in order to allow local regulations and traditions being fully adopted.

2.3 Purpose of the training

Buildings are responsible for approximately 40% of the total annual energy consumption in Europe. Furthermore, it has been established that households, in developed countries, spend slightly more than half of their total energy needs (approximately 52%) for space heating and cooling. Taking also into account studies showing that there is a major room for improvement on the energy saving of the building sector in general, one can realize that the buildings' sector will be a key element in achieving Europe's 2020 energy targets (20% reduction on energy use, 20% use of renewable energy and 20% reduction of CO_2 emissions). Near Zero Energy Buildings (nZEB) coming into effect from 2019 (31st December 2018) onwards will prove a major asset towards this direction.

Professionals involved in the building's design and construction sector will need to fully familiarize themselves with the nZEB definition and concept in order to minimize the risks of unintended poor design and "building energy performance". These risks include excess humidity (unable to escape the building envelope), problems in different materials bonding together, oversized or inefficient systems resulting in increased costs, etc. Basic interdisciplinary knowledge is essential in order for professionals of diverse backgrounds to harmonically cooperate within a team with sole purpose the optimum design and construction of an nZEB building regarding technical and financial aspects.

The purpose of the training is to inform building professionals and other stakeholders about the related European Directives and mandatory legislation and regulation regarding the energy performance of buildings and demonstrate the basic concepts, physics and techniques and how these are applied in simple steps leading to the design of a near Zero Energy Building.

The aspects that will be covered in this training module are as follows:

- Introduction to the nZEB concept
- European Directives
- Local legislation and regulations (differentiation between target countries)
- The building envelope
- Different constructions of the building envelope
- Windows, shading systems and facades
- Thermal insulation materials of the present
- High performance thermal insulation materials (new and future trends)

- HVAC systems
- nZEB examples.

2.4 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience (course, webinar, self-study or group activity). Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experiences.

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials.

Learning objectives:

- Provide clarity about the purpose of the course;
- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals;
- Establish accountability between the learner and the instructor;
- Help trainers articulate exactly what they want participants to do by the end of the training.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound.

The learning objectives of Module 1 are as follows (specific):

- To understand the definition and concept of an nZEB building and to familiarize with key building parameters towards the aforementioned goal.
- To introduce or refresh the basics regarding the physics applicable in energy consumption of buildings in general and nZEB in particular.
- Introduction of current market and near-future coming insulating materials and their respective advantages and disadvantages over one another.
- To familiarize with current building envelope various construction techniques and their respective benefits or flaws.
- To introduce the state of the art and most efficient market available electromechanical systems used in building design and construction.
- To present the available renewable energy sources for nZEBs, as far as technology and legal framework is concerned, and present the minimum RES requirements in an nZEB.

Measurable – learners, after completing the course, are able to identify the key parameters and requirements that lead to the design of a near Zero Energy Building and the resulting benefits (financial and more) to its owners, tenants, managers, etc. Learners will also be able to follow various design paths leading to the design of an nZEB building using the most adequate methodology.

Action – learners will be able to address the implementation of nZEB development within their own work, taking into consideration the various particularities and different possibilities in each particular case study. They will also be able to explain to prospective clients, colleagues and other stakeholders the issues involved in the design and development of an nZEB building.

Reasonable – PowerPoint slides are supported by reading documents recommended to be studied before and after attending the course and additional material is presented as bibliography in each section; the learning required is commensurate with the objective.

Time-bound – learning will be completed after the training and completion of course reading.

2.5 Learning audience – trainers and trainees – qualifications and experience

The trainers and trainees will be those professionals involved in the design and construction of buildings, as well as those involved in the building regulation system. Professions will include engineers, architects, building supervisors, site managers and building auditors. Government and local authorities officials involved in the regulation of energy efficient buildings will also be included.

The trainers should be members of a relevant construction profession and have extensive experience, at least five years' experience in practice of the design and construction of buildings, preferably of energy efficient buildings. Experience of supervision of staff and previous experience in delivering training and courses would also be useful.

The trainees include the building professionals described above, but with any number of years' experience from graduation through to senior company Directors.

3 STRUCTURE OF MODULE 1 – BASIC MODULE

The estimated duration of the training is 20 hours. The structure of the training course is as follows:

- **Preparation** – involving an on-line introduction and background reading; the approximate duration is 4 hours;
- **Class based training** – involving delivery by a trainer of the main components of the training. The delivery will be given by the approved trainer in modules split in 2-hour sessions. The approximate duration of the classroom training will be 12 hours;
- **Post classroom based training, self-learning and exam preparation**. The training will include on-line reading and, where possible, video presentation from actual building examples to demonstrate good and bad practice, as well as short self-assessment tests, based on the contents and functionalities of the e-learning platform. The approximate duration of this part of the training will be 3 hours;
- **Competence assessment**: this will be delivered through a one hour written exam after the completion of the training course and will be structured in a combination of multiple-choice questions and calculation questions. 1 hour should be allocated to complete the exam.

3.1 Time Allocation of M1- Basic Module

It is foreseen to have 12 hours of class room training, distributed per section as follows, and a one hour exam:

- Session 1 – Introduction and the nZEB concept (0.5h)
- Session 2 – European Directives and national legislation (3.0h)
- Session 3 – Basic physics and the Building Envelope (2.0h)
- Session 4 - Thermal insulation materials and current technology trends (2.5h)
- Session 5 – HVAC systems in buildings and basic concepts (3.0h)
- Session 6 – Practical session: nZEB design example (1.0h)
- Exam (1.0h).

3.2 Course reading material

A number of documents are indicated as necessary (pre-course and post-course) and additional reading material related to legislation, building certification and key parameters, European Directives, etc. is pointed out.

Pre-classroom

nZEB definitions, Standards on the Energy Performance of Buildings and bibliography:

EN ISO 13790:2008 Energy Performance of Buildings – Calculation of energy use for space heating and cooling

EN 15242:2006 Ventilation for buildings – Calculation methods for the determination of air flow rates in buildings including infiltration

NEN 2916:1998 Energy performance of non-residential buildings. Determination method

2010/31/EU Directive of the European Parliament and of the Council on the energy performance of buildings (recast)

2009/28/EC Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources.

National building regulations / standards relevant to energy performance of buildings:

Cyprus

Laws

- N142(I)/2006 – On the Regulation of the Energy Performance of Buildings Law 2006
- N30(I)/2009 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2009
- N210(I)/2012 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2012.

Decree Laws & Regulations

- ΚΔΠ 164/2009 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) Regultions 2009
- ΚΔΠ 39/2014 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) (Amendment) Regultions 2014
- ΚΔΠ 412/2009 - On the Regulation of the Energy Performance of Buildings (Energy Performance Certificates of Buildings) Decree 2009
- ΚΔΠ 432/2013 - On the Regulation of the Energy Performance of Buildings (Minimum Requirements on the Energy Performance of Buildings) Decree 2013
- ΚΔΠ 432/2013 - On the Regulation of the Energy Performance of Buildings (Recommendations for the Improvement of the Energy Performance of Buildings and Energy Performance Certificate of Buildings) Decree 2013
- ΚΔΠ 33/2015 - On the Regulation of the Energy Performance of Buildings (Methodology on the Energy Assessment of Buildings) Decree 2015
- ΚΔΠ 164/2009 – The Streets and Buildings (Energy Performance of Buildings) Regulations 2009
- ΚΔΠ 61/2014 – The Streets and Buildings (Energy Performance of Buildings) (Amendment) Regulations 2014

- ΚΔΠ 343/2013 – On the Regulation of the Energy Performance of Buildings (Methodology for the calculation of the Cost Optimal minimum Requirements on the Energy Performance of Buildings) Decree 2013

- ΚΔΠ 386/2013 – On the Regulation of the Energy Performance of Buildings (Requirements on New Technical Building Systems installed in existing buildings or building units and technical systems that are replaced or upgraded) Decree 2013

- ΚΔΠ 366/2013 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB) Decree 2014

- ΚΔΠ 163/2009 - On the Regulation of the Energy Performance of Buildings (Cooling Systems Inspection) Regulations 2009

- ΚΔΠ 413/2009 - On the Regulation of the Energy Performance of Buildings (Cooling Systems Inspection) Decree

- ΚΔΠ 244/2015 - On the Regulation of the Energy Performance of Buildings (regulation and control of cooling systems of nominal power output greater than 20 kW) Decree

- ΚΔΠ 119/2011 - On the Regulation of the Energy Performance of Buildings (Inspection of boiler based Heating Systems) Regulations 2011

- ΚΔΠ 148/2013 - On the Regulation of the Energy Performance of Buildings (Inspection procedure of heating systems equipped with a boiler of nominal power between 20 kW and 100 kW) Decree 2013

- ΚΔΠ 149/2013 - On the Regulation of the Energy Performance of Buildings (Inspection procedure of heating systems equipped with a boiler of nominal power greater than 100 kW) Decree 2013

- ΚΔΠ 244/2013 - On the Regulation of the Energy Performance of Buildings (regulation and control of heating systems equipped with a boiler of nominal output power greater than 20 kW) Decree 2013.

Greece

Greek Law 3661/2008 “Measures to reduce energy consumption in buildings and other provisions”Regulation for Energy Efficiency of Buildings (KENAK) issued in 2010 (Official Gazette Bulletin B’ 407/09-04-2010), based on the Greek Law 3661/2008

Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B’ 1387-2010 and 1413-2012

Greek Law 3851/2010 “Accelerating the Development of Renewable Energy Sources (RES) to Deal with Climate Change and Other Regulations in Topics under Authority of the Greek Ministry of Environment, Energy, and Climate Change”

Greek Law 4122/2013 “Energy Performance of Buildings – Transposition of Directive 2010/31/EU”, which integrated the recast EPBD Directive 2010/31/EU

New Building Regulation (Greek Law 4067/2012).

Italy

Italian Legislative Decree 28/2011 transposing the Renewable Energy Services (RES) Directive - requirements regarding the share of renewable energy for new buildings and major renovations were increased

The Italian Legislative Decree 192/2005 - general framework for the transposition of the EPBD at national level, setting the minimum requirements for the Energy Performance (EP), and the U-values for windows, walls, floors and roofs, in case of new buildings and major renovations.

The Italian Presidential Decree n. 59 - calculation methodologies and minimum requirements to the summer EP of cooling and lighting systems; minimum requirements for the EP of buildings and of heating systems.

D.L. 63/2013 Disposizioni urgenti per il recepimento della Direttiva 2010/31/UE del Parlamento europeo e del Consiglio del 19 maggio 2010, sulla prestazione energetica nell'edilizia per la definizione delle procedure d'infrazione avviate dalla Commissione europea, nonche' altre disposizioni in materia di coesione sociale. (13G00107) (GU Serie Generale n.130 del 5-6-2013).

Decreto Ministeriale 26/06/2015, Ministero dello Sviluppo Economico - Adeguamento del decreto del Ministro dello sviluppo economico, 26 giugno 2009 - Linee guida nazionali per la certificazione energetica degli edifici.

Portugal

Portuguese Energy Strategy (NES 2020)

Portuguese Building Thermal Legislation - Decree-Law 118/2013, Updated by Decree-Law 68 -A/2015, Decree-Law 194/2015, Decree-Law 25/2016 and related Ordinances and Mandamus.

National Energy Efficiency Action Plans (NEEAP) and National Renewable Energy Action Plans (NREAPs).

Post classroom

The post classroom study includes the following:

- EPC – national methodology;
- EPC generating software;
- Assessment techniques;
- Best practice details.

The post classroom study will also include identification of good and bad practices.

National bibliography and publications on the energy performance and certification of buildings:

Cyprus

Cyprus Energy Service, “Thermal Insulation Guide”, 2nd edition, 2009.

Cyprus Energy Service, “National Methodology for Assessing the Energy Performance of Buildings”, 2009.

Cyprus Energy Service, “Guide on near Zero Energy Buildings”, 2014.

Greece

Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B’ 1387-2010 and 1413-2012 and more specifically the technical guidelines of series 20701 (20701-1, 20701-2, 20701-3, 20701-4 and 20701-5).

Software TEE-KENAK, through which the EPCs are issued.

Example of issuing an EPC through inspection in residences. The example is provided through the website of the Technical Chamber of Greece and more specifically in the following path: http://portal.tee.gr/portal/page/portal/SCIENTIFIC_WORK/GR_ENERGEIAS/kenak/CaseStudy-KENAK-multihouse%20-%2014_05_2012-final.pdf

Italy

Trabace Raffaele, La certificazione energetica, 2014

Wienke Uwe, L'edificio passivo. Standard, requisiti, esempi, 2002

Mazzucchelli E.S., Edifici ad energia quasi zero, 2013

Marcella Bonanomi, Claudia de Flumeri, Monica Lavagna, Edifici a consumo energetico zero. Orientamenti normativi, criteri progettuali ed esempi di Zero Energy e Zero Emission Buildings, 2012

Portugal

Portuguese Building Thermal Legislation - Decree-Law 118/2013, Updated by Decree-Law 68 -A/2015, Decree-Law 194/2015, Decree-Law 25/2016 and related Ordinances and Mandamus.

ADENE – Energy Efficiency Guide (Guia da eficiência energética) (http://www.adene.pt/parceiro/guia-de-eficiencia-energetica)

ADENE – Efficient Roofs – Guides to the Energy and Environmental Renovation of the Building Stock (Coberturas Eficientes - Guias para a Reabilitação Energético-Ambiental do Edificado) (http://www.adene.pt/parceiro/coberturas-eficientes-guias-para-reabilitacao-energetico-ambiental-do-edificado)

ADENE – Wall insulation – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE – Roof insulation – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE – Solar shading – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE – Ventilation Systems – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE - Solar thermal systems – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE – Fireplaces with heat recovery and salamander stove - – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE – Gas water heater and boilers – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE – Domestic Air-conditioning systems – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE – Photovoltaic solar systems - – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica).

4 CONTENT OF MODULE 1 – BASIC MODULE

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content will be split into six sessions that will be run over the entire training course duration. Each session will be introduced by the trainer and the connection with the learning objectives and outcomes explained. The sessions will vary in timing and content. The course material will be delivered through PowerPoint slides, which are made available to the trainees. The trainers have additional notes available to them on the PowerPoint slides. Additionally, there is a practical session on the design of an nZEB building from scratch, fulfilling all the certification (EPC) requirements for a newly designed building that will apply for a building permit.

The sessions are described in this section, including relevance to the objectives and the learning outcomes.

The six sessions are as follows:

- Session 1 – Introduction and the nZEB concept (0.5h) – prepared by CUT

    1. Introduction to nZEB
    2. Defining Building details and near Zero Energy Building

- Session 2 – European Directives and National Legislation (3.0h) - prepared by CUT

    1. EPBD and RED Directives
    2. National legislation, building codes, regulations and guidelines, (prepared by partners in each target country)

- Session 3 – Basic physics and the building envelope (2.0h) - prepared by CUT

    1. Basic physics of Buildings
    2. The Building Envelope
    3. Thermal Losses Mechanisms

- Session 4 – Thermal insulation materials and current technology trends (2.5h) - prepared by CUT

    1. Introduction to Insulation materials
    2. Pros and Cons
    3. Current trends and emerging technologies
    4. Thermal Insulation construction techniques
    5. Examples of best/bad practices
    6. Risks

- Session 5 – HVAC systems in buildings and basic concepts (3.0h) - prepared by CUT

    1. Introduction to HVAC systems
    2. Basic thermodynamics and psychrometry
    3. The human need behind heating and cooling and thermal comfort zones
    4. HVAC units and their categories
        4.1 Air systems
        4.2 Water systems
        4.3 Combi systems
    5. Heat Recovery Units and need
    6. Air Supply Systems
    7. The Cooling Cycle
        7.1 Energy and thermodynamics of the cooling cycle
        7.2 Refrigerants, selection, properties etc.
        7.3 Cooling cycle parts (heat exchangers, compressors, expansion valves, etc.)

- Session 6 – Practical Session: nZEB design example (1.0h) - prepared by CUT

    1. Examples of near Zero Energy Buildings
    2. nZEB from scratch (designing an nZEB building from an EPC requirements approach)

- Exam (1.0h) - prepared by CUT (from pool of questions prepared by KEK)

    One-hour written exam.

For each slide of the document, in the notes section, an explanation of what is the purpose of the slide and further notes related with the content are presented. This is used to help the trainer to further develop the topic or to pinpoint the most relevant aspects that should be referred during the workshops and seminars. In other situations, only tables and graphs are presented in the slides, the notes sections have the most relevant aspects that must be referred by the trainer and the source (presented in a more detailed manner than the one in the slide) of the figure or table is also listed. So, if the trainer wants to further develop the content of the slide, he/she can easily search for the document (**Figure 1**).

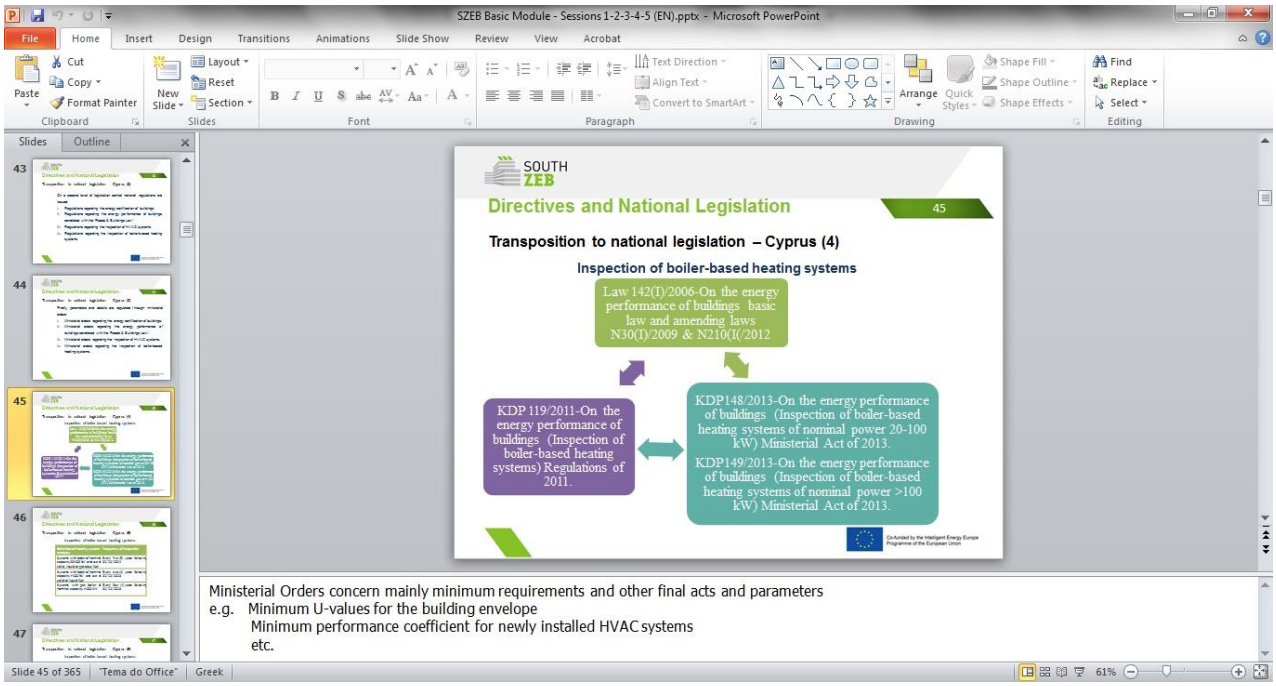

Figure 1 - Screenshot of a slide showing the slide notes

At the end of the session a list of bibliographic references are presented (**Figure 2**), the trainees can further develop their training through the study of the documents listed.

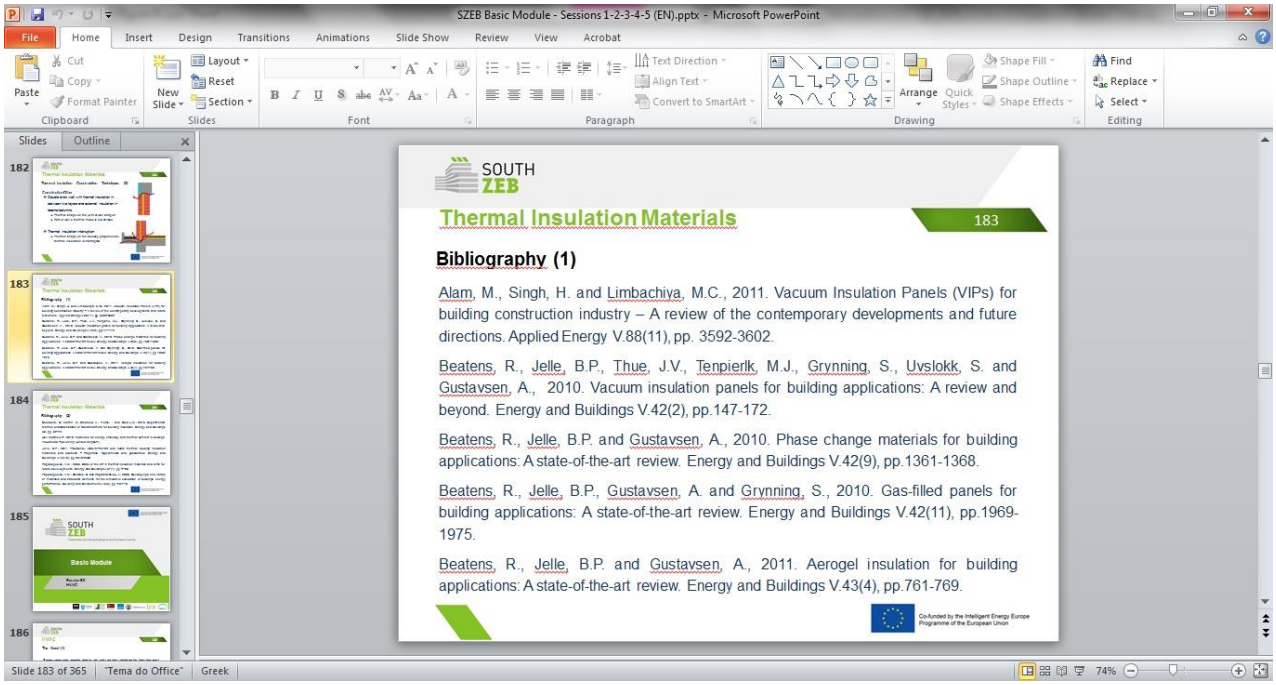

Figure 2 - Screenshot of a slide showing the bibliography of the session

4.1 Session 1: Introduction and the nZEB concept

Learning objectives of Session 1 - Introduction

The learning objectives of Session 1 are as follows:

- To understand the definition and concept of an nZEB building.
- To understand the history and motives behind the goal for nZEB buildings.

Content of Session 1 - Introduction

The first session of the training module addresses the history leading to the roadmap of the nZEB buildings, the EPBD directive and the nZEB definition:

- Introduction to the topic
- nZEB concept and definition
- evolution of building energy use and building efficiency targets and regulations.

The presentation explains the impact of buildings in energy consumption in developed countries, presents a review of the various focus areas and points of interest throughout the years related to building energy consumption and efficiency and provides the resulting regulations and directives that came into force, leading to the EPBD recast in 2010. Finally, the nZEB concept and definition is given.

Session 1 is related with the global context, thus no national context is presented.

Session's 1 estimated duration is 0.5 hours.

Summary of Session 1

Buildings consume around 40% of the total primary energy consumption in the EU.

There is high energy saving potential regarding buildings

nZEB: a building with near zero energy consumption, i.e. a building with very high energy performance which is defined according to Annex I. (EU definition located in the EPBD recast)

Learning outcomes of Session 1

The outcomes from Session 1 will be as follows:

- Knowledge of the concept and definition of nZEB;
- Knowledge of the energy consumption of buildings in general;

Bibliography of Session 1

2010/31/EU Directive of the European Parliament and of the Council on the energy performance of buildings (recast)

2009/28/EC Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources

406/2009/EC Decision of the European Parliament and of the Council on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

Official Journal of the European Union, "Climate, environment, energy and transport", E28-29, 2013

2006/32/EC Directive of the European Parliament and of the Council on energy end-use efficiency and energy services.

4.2 Session 2: European Directives and national legislation

Learning objectives of Session 2

The learning objectives of Session 2 are as follows:

- To familiarize and learn the European Directives which constitute the driving forces towards the nZEB milestones.
- To learn and understand local national legislation and regulations regarding the energy performance of buildings.
- To understand and being able to implement all related national legislation and regulations during the design, construction and operation of an nZEB building.

Content of Session 2

The second session of the training module addresses the two most relevant EU Directives related to the energy performance of buildings in general and the nZEB concept in particular; 2010/31/EU (EPBD recast) and 2009/28/EC (RED). In particular, session 2 addresses the following:

- EPBD recast directive (2010/31/EU) and its general requirements on an EU level;
- RES directive (2009/28/EC) and its general requirements on an EU level;
- Transposition of the above EU directives on a national level in each target countries and the subsequent national legislation and regulations.

Session 2 presents the general context of the EPBD and RES European directives and the requirements and 2020 targets emanating from these directives on an EU level, as well as how these are translated to individual key performance indicators for each Member State in general and for the four target countries in particular.

The 2020 targets on primary energy consumption, greenhouse gas emissions and utilisation of renewable energy in each target country are presented along with the national legislation regarding the promotion of renewable energy sources and the energy performance of buildings. In specific, the national legislation regarding the energy performance certification of buildings, the inspection and efficiency of heating and cooling systems, energy requirements on large scale retrofits of current building stock, efficiency of systems etc. are presented.

Session's 2 estimated duration is 3.0 hours.

Summary of Session 2

EPBD recast directive sets the mandatory goal for nZEB buildings for new constructions owned or occupied by the public sector by 31st December 2018 and onwards.

EPBD recast directive sets the mandatory goal for nZEB buildings for new constructions owned or occupied by the public or private sector by 31st December 2020 and onwards.

Each member state is required to set its own parameters based on cost-optimal levels to define the nZEB building.

Each Member State is required to reach specific key performance indicators regarding the penetration level of renewable energy sources in its primary energy consumption balance by 2020.

Learning outcomes of Session 2

The outcomes from Session 2 will be as follows:

- Knowledge of related EU directives on the energy performance of buildings and renewable energy sources;
- Knowledge of the national legislation and regulations in each target country related to energy performance of buildings and renewable energy sources;
- Ability to implement the national legislation and regulations during the design, construction and operation of an nZEB building.

Bibliography of Session 2

2010/31/EU Directive of the European Parliament and of the Council on the energy performance of buildings (recast)

2009/28/EC Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources.

Cyprus

Laws

- N142(I)/2006 – On the Regulation of the Energy Performance of Buildings Law 2006

- N30(I)/2009 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2009

- N210(I)/2012 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2012

Decree Laws & Regulations

- ΚΔΠ 164/2009 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) Regulations 2009

- ΚΔΠ 39/2014 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) (Amendment) Regulations 2014

- ΚΔΠ 412/2009 - On the Regulation of the Energy Performance of Buildings (Energy Performance Certificates of Buildings) Decree 2009

- ΚΔΠ 432/2013 - On the Regulation of the Energy Performance of Buildings (Minimum Requirements on the Energy Performance of Buildings) Decree 2013

- ΚΔΠ 432/2013 - On the Regulation of the Energy Performance of Buildings (Recommendations for the Improvement of the Energy Performance of Buildings and Energy Performance Certificate of Buildings) Decree 2013

- ΚΔΠ 33/2015 - On the Regulation of the Energy Performance of Buildings (Methodology on the Energy Assessment of Buildings) Decree 2015

- ΚΔΠ 164/2009 – The Streets and Buildings (Energy Performance of Buildings) Regulations 2009

- ΚΔΠ 61/2014 – The Streets and Buildings (Energy Performance of Buildings) (Amendment) Regulations 2014

- ΚΔΠ 343/2013 – On the Regulation of the Energy Performance of Buildings (Methodology for the calculation of the Cost Optimal minimum Requirements on the Energy Performance of Buildings) Decree 2013

- ΚΔΠ 386/2013 – On the Regulation of the Energy Performance of Buildings (Requirements on New Technical Building Systems installed in existing buildings or building units and technical systems that are replaced or upgraded) Decree 2013

- ΚΔΠ 366/2013 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB) Decree 2014

- ΚΔΠ 163/2009 - On the Regulation of the Energy Performance of Buildings (Cooling Systems Inspection) Regulations 2009

- ΚΔΠ 413/2009 - On the Regulation of the Energy Performance of Buildings (Cooling Systems Inspection) Decree

- ΚΔΠ 244/2015 - On the Regulation of the Energy Performance of Buildings (regulation and control of cooling systems of nominal power output greater than 20 kW) Decree

- ΚΔΠ 119/2011 - On the Regulation of the Energy Performance of Buildings (Inspection of boiler based Heating Systems) Regulations 2011

- ΚΔΠ 148/2013 - On the Regulation of the Energy Performance of Buildings (Inspection procedure of heating systems equipped with a boiler of nominal power between 20 kW and 100 kW) Decree 2013

- ΚΔΠ 149/2013 - On the Regulation of the Energy Performance of Buildings (Inspection procedure of heating systems equipped with a boiler of nominal power greater than 100 kW) Decree 2013

- ΚΔΠ 244/2013 - On the Regulation of the Energy Performance of Buildings (regulation and control of heating systems equipped with a boiler of nominal output power greater than 20 kW) Decree 2013.

Greece

- Greek Law 3661/2008, issued on the 19th of May 2008

- Greek Regulation for the Energy Efficiency of Buildings, issued on 2010

- The recast EPBD Directive 2010/31/EU was integrated in the Greek legislation through the Greek Law 4122/2013.

- Technical Guidelines for the implementation of the Greek Regulation for the Energy Efficiency of Buildings issued by the Technical Chamber of Greece (Official Gazette Bulletin B' 1387-2010 and 1413-2012)

- New Building Legislation 4067/2012

- Greek Law 3851/2010.

Italy

Italian Legislative Decree 28/2011 transposing the Renewable Energy Services (RES) Directive - requirements regarding the share of renewable energy for new buildings and major renovations were increased

The Italian Legislative Decree 192/2005 - general framework for the transposition of the EPBD at national level, setting the minimum requirements for the Energy Performance (EP), and the U-values for windows, walls, floors and roofs, in case of new buildings and major renovations.

The Italian Presidential Decree n. 59 - calculation methodologies and minimum requirements to the summer EP of cooling and lighting systems; minimum requirements for the EP of buildings and of heating systems.

D.L. 63/2013 Disposizioni urgenti per il recepimento della Direttiva 2010/31/UE del Parlamento europeo e del Consiglio del 19 maggio 2010, sulla prestazione energetica nell'edilizia per la definizione delle procedure d'infrazione avviate dalla Commissione europea, nonche' altre disposizioni in materia di coesione sociale. (13G00107) (GU Serie Generale n.130 del 5-6-2013).

Decreto Ministeriale 26/06/2015, Ministero dello Sviluppo Economico - Adeguamento del decreto del Ministro dello sviluppo economico, 26 giugno 2009 - Linee guida nazionali per la certificazione energetica degli edifici.

Portugal

Portuguese Energy Strategy (NES 2020)

Portuguese Building Thermal Legislation - Decree-Law 118/2013, Updated by Decree-Law 68 -A/2015, Decree-Law 194/2015, Decree-Law 25/2016 and related Ordinances and Mandamus.

National Energy Efficiency Action Plans (NEEAP) and National Renewable Energy Action Plans (NREAPs).

4.3 Session 3: Basic physics and the building envelope

Learning objectives of Session 3

The learning objectives of Session 3 are as follows:

- To understand the definition of the building envelope and familiarize with the building elements that constitute the building envelope.
- To understand the basic mechanisms of thermal losses and gains through the building envelope.
- To familiarize with shading systems and their impact on the energy losses and gains of a building.
- To understand the major building elements and their contribution towards the energy losses through the building envelope.

Content of Session 3

Session 3 of the training module addresses the basic physics and thermal losses/gains mechanisms through the building envelope, in particular the following:

- Definition of the building envelope;
- Elements that constitute the building envelope;
- Thermal losses and gains mechanisms;
- Shading systems and their impact on the building energy losses;
- Contribution of each envelope building element in the building energy losses balance.

The presentation explains the definition of the building envelope and the building elements that this is comprised of and the dominant thermal losses and gains mechanisms are presented in detail based on the prevailing temperatures between the external environment and the internal of the building as well as the internal and external surface temperatures of the building envelope. Furthermore, the basic physics of the glazing and shading systems are presented, how these allow or block solar radiation and their impact on utilizing or avoiding the provided solar energy.

Session's 3 estimated duration is 2.0 hours.

Summary of Session 3

The building envelope is comprised by every element of the building that connects the building's conditioned spaces with the external environment or any other adjoined constructions

Buildings lose around 35% of their energy through the walls, 25% through the roof, 15% through the ground, 10% through glazing and 15% through air infiltration.

Shading systems help towards utilizing solar energy during the winter and block unwanted solar radiation during the summer.

Learning outcomes of Session 3

The outcomes from this session are related to the definition and basic physics of the building envelope.

Learners will learn and understand the dominant mechanisms of thermal losses/gains through the building envelope and how these are influenced through design alterations and construction materials selection.

Bibliography of Session 3

Pitts D, Sissom L., Schaum's Outline of Heat Transfer, 2nd Edition 2011

Cengel Y. Heat Transfer: A Practical Approach, 2nd Edition, 2002

Sissom and Pitts, Elements of Transport Phenomena, McGraw-Hill, 1972

4.4 Session 4: Thermal insulation materials and current technology trends

Learning objectives of Session 4

The learning objectives of Session 4 are as follows:

- To familiarize with the most commonly used thermal insulation materials and get to know their properties and characteristics.
- To understand the advantages and disadvantages of each thermal insulation material and be able to compare one with another.
- To familiarize with state of the art thermal insulation materials and their properties and characteristics.
- To learn current technology trends and thermal insulation materials that are expected to be developed in the near future.

- To familiarize with current construction techniques in regards to the application of thermal insulation in buildings and the advantages and disadvantages of each one of them.

Content of Session 4

Session 4 of the training module addresses thermal insulation materials, their properties and characteristics, their advantages and disadvantages, their applications, etc. In particular, session 4 addresses the following:

- Definition of a thermal insulating material
- Most commonly used thermal insulation materials of the present
    - Type of materials
    - Properties and characteristics
    - Advantages and disadvantages
    - Comparison
- State of the art thermal insulation materials
    - Type of materials
    - Manufacturing processes
    - Properties and characteristics
    - Advantages and disadvantages
    - Comparison
- Emerging technologies in thermal insulation materials of the future
- Construction techniques and applications of thermal insulation materials in buildings

Session's 4 estimated duration is 2.5 hours.

The session will commence by presenting the definition of what is considered to be a thermal insulating material. It will continue by presenting the most commonly used thermal insulation materials, their properties (mechanical properties, thermal properties, resistance to wear, etc.) and characteristics, their advantages and disadvantages and finally a comparison between them and which type of material is suitable in various types of applications.

Following, the session continuous in presenting the state of the art thermal insulation materials, their properties (mechanical properties, thermal properties, resistance to wear, etc.) and characteristics, their advantages and disadvantages and how these are compared to the typical thermal insulation materials of today.

Furthermore, the emerging technologies of future thermal insulation materials will be presented and what is to be expected in the near future in regards to the properties, characteristics and performance of thermal insulation materials of the near future will follow. Finally, the basic construction techniques and applications of thermal insulation materials in buildings are shown and a comparison is given on their advantages and disadvantages, as well as, to which technique is suitable in respect to the desired design outcome.

Summary of Session 4

A thermal insulating material is every material with a linear thermal conductivity coefficient $\lambda \leq 0.1$ W/m^{2}K.

Current thermal insulating materials present a linear thermal conductivity coefficient close to $\lambda \approx 0.03\text{-}0.04$ W/m^{2}K.

State of the art thermal insulating materials present a linear thermal conductivity coefficient close to λ≈0.005-0.015 W/m^{2}K.

Future thermal insulating materials are expected to reach a linear thermal conductivity coefficient close to λ≈0.001-0.004 W/m^{2}K, as well as increased durability and minimum properties' deterioration throughout their lifetime of operation.

In cases where thermal mass is important and minimization of thermal bridging is required, thermal insulation is applied in the external part of the building envelope.

In cases where fast response of the heating and cooling systems is required and spaces are not used for prolonged period of times, thermal insulation is applied in the internal side of the building envelope.

Learning outcomes of Session 4

The outcomes of this session for learners will be to familiarize themselves with thermal insulation materials that are currently mostly used, as well as state of the art thermal insulation materials and materials of the near future. Learners will get to know and understand the properties and characteristics of each thermal insulation material, learn to compare the various thermal insulation materials and be able to select the most suitable thermal insulation material for a specific construction. Finally, learners will get to know and understand the various construction techniques and how thermal insulation materials are applied in buildings and be able to propose the most suitable technique depending the desired design outcome.

Bibliography of Session 4

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Papadopoulos, A.M., Oxizidis, S. and Papathanasiou, L., 2008. Developing a new library of materials and structural elements for the simulative evaluation of buildings' energy performance. Building and Environment V43(5), pp.710-719.

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4.5 Session 5: HVAC Systems in buildings and basic concepts

Learning objectives of Session 5

The learning objectives of Session 5 are as follows:

- To present the human body requirements as far as the comfort is concerned (Temperature, humidity, radiation, air flow etc.)
- To present the basics of thermal comfort requirements that lead to the need and use of HVAC Systems.
- To present the basic Energy balance as far as the thermal load (for heating and cooling) calculations
- To present the most common, as well as, advanced systems used to regulate the internal environment in buildings
    - Heating and cooling systems
    - Air supply systems
    - Heat recovery units
    - Cooling towers
- To present the various parts and necessary/main auxiliaries of HVAC systems
- To present the basics on the used refrigerants and the necessary precautions in their handling
- To present the basics on the selection of the most suitable HVAC system depending the application.

Content of Session 5

Session 5 will address the basic human need with respect to human activity, in particular the following:

- Basics knowledge

  Definitions and measurements of temperature, humidity, air flow, radiation, clothing
    - Human Comfort and statistics
    - Basic human needs…

  Heating and Cooling

- Cooling load calculations…
- Heating load calculations
- Thermal Load calculations
- Shading calculations

- Basic Modern Systems
  - Air systems
  - air/water systems
  - water only systems
  - Independent systems
- Basics of psychrometry
  - Chart
  - Calculations
- Air supply Systems
  - CO_2
  - Odours
  - Excess humidity
  - Smoke
  - Chemicals
- Energy recovery systems
- Energy and Basic Thermodynamics
  - Cooling Cycles
  - Parts and devices
  - Modern systems and refrigerants

Session's 5 estimated duration is 3.0 hours.

The session will commence by presenting the definition of the basic need for comfort and what is considered to be a comfortable environment. It will continue by presenting the most commonly used environments, the human activity and the needs for such an activity.

The session for the thermal load calculations will follow explaining the cooling/heating load and ways to achieve an optimum system performance. This will need into the basics of psychrometry and the use of the psychrometric chart.

In addition the various systems of air supply will be introduced along with the need for such systems, explaining the allowable limits of CO_2, smoke, odour and the like upper limits. The introduction of Energy recovery systems will follow explaining the savings and the basic technology that is used today. The presentation will end with the basics of energy laws and basic calculations. Presenting examples of heating and cooling loads.

Summary of Session 5

There is a basic need for thermal comfort which depends on the human activity in the room. This is determined by standards which are to be followed. The standards give the environmental conditions and one needs to know how to do the calculations to keep these parameters within the required limits. In the process of doing the calculations to keep the parameters one need to know the basic energy laws and psychrometry. At last, one needs to know the various mechanical parts and their economics in order to make a decision as to their performance to satisfy the necessary needs in the room/house.

Learning outcomes of Session 5

The outcomes of this session for learners will be to become familiar with the need for thermal comfort and the basic calculations to achieve this basic need. In the process they will need to recall energy (heating and cooling load) along with air flow calculations to achieve a viable systems offering a healthy environment. As a final word the trainees will get introduced to the actual mechanical systems needed to achieve all of the above.

Bibliography of Session 5

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2015 ASHRAE Handbook-HVAC Applications

2014 ASHRAE Handbook-Refrigeration

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CIBSE Guide B2: Ventilation and ductwork, 2016

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Nils R. Grimm, Robert C. Rosaler. Handbook of HVAC Design. McGraw Hill.

4.6 Session 6: Practical Session: nZEB design example

Learning objectives of Session 6

The learning objectives of Session 6 are as follows:

- To present best practice examples on the design and construction of near Zero Energy Buildings.
- To familiarize with the key definitions and parameters leading to a near Zero Energy Building based on an energy performance certification approach.
- To become able to design and certify a building to a near Zero Energy level based on an energy performance certification approach.

Content of Session 6

In this session, the different standards and methods to assess the energy performance of buildings are presented, as well as the available national software tools to produce an energy performance certificate (EPC), namely the following:

- Energy Performance of Buildings
    - EN ISO 13790
- EPC Software tools
    - iSBEMcy (Cyprus)
    - TEE - KENAK (Greece)
    - TerMus, Termolog EpiX, Namirial Termo, Mc4 Suite, Edilclima, Leto, DOCET (Italy)
    - Software for the application of the methodology defined in the Portuguese Building Thermal Legislation - Decree-Law 118/2013, Updated by Decree-Law 68 -A/2015, Decree-Law 194/2015, Decree-Law 25/2016 and related Ordinances and Mandamus (Portugal).
        - Excel file for the application of the methodology defined in the Portuguese thermal code for residential buildings (Folha de cálculo de apoia à aplicação do REH - Portugal) - FC_REH_XML (http://www.itecons.uc.pt/p3e/)
        - Excel file for the application of the methodology defined in the Portuguese thermal code for non-residential buildings (Folha de cálculo de apoia à aplicação do RECS - Portugal) - FC_DL118_2013_CDM_RECS (http://www.itecons.uc.pt/p3e/)
        - Excel file for the calculation of the CO_2 concentration (Folha de cálculo para a determinação da concentração de CO_2 - Portugal) - CO2_Custos_MONOZONA (http://www.itecons.uc.pt/p3e/)
        - Excel file for the calculation of the ilumination and apliances power and use profiles (Folha de cálculo para a determinação da das potências de iluminação e equipamentos e estabelecimento de perfis de utilização - Portugal) - Levantamento_Equips_Ventil_Ilumin_Ocupacao (http://www.itecons.uc.pt/p3e/)
        - Excel file for the calculation of ventilation rates according to the Portuguese thermal code (Folha de cálculo para a determinação da taxa de ventilação (Portugal) - Qventila_RECS and VENTILACAO_Rph (http://www.lnec.pt/pt/servicos/ferramentas/aplicacoes-informaticas/eficiencia-energetica/)

The duration of this session is estimated in 1.0h.

Summary of Session 6

Session 6 focuses on best practise examples related to near Zero Energy Buildings or buildings of high energy efficiency, from which one can draw ideas and paradigms that contribute to the design and construction of a near Zero Energy Building.

EN ISO 13790 presents the methodology for the assessment of the energy performance of buildings and the energy requirements for space heating and cooling. This consists the basis for all national methodologies in EU Member States on the assessment of the energy performance of buildings and the

subsequent certification. The national software used for the certification of buildings will be presented (iSBEMcy for Cyprus, TEE – KENAK for Greece, TerMus, Termolog EpiX, Namirial Termo, Mc4 Suite, Edilclima, Leto and DOCET for Italy, FC_REH_XML, FC_DL118_2013_CDM_RECS, CO2_Custos_MONOZONA, Qventila_RECS, VENTILACAO_Rph and Levantamento_Equips_Ventil_Ilumin_Ocupacao for Portugal) and participants will familiarize themselves with the design of a near Zero Energy Building following an energy performance certification approach and getting to grips with the minimum requirements of (U-values of walls and windows, HVAC performance coefficients, maximum primary energy consumption, RES installation) in a building that lead to an nZEB level.

Learning outcomes of Session 6

The outcomes from this session are related with best practice examples on already constructed near Zero Energy Buildings as well as buildings of high energy efficiency, as well as familiarization with the design and certification of a near Zero Energy Building.

Learners will be able to explain and interpret the standards, at international and national level, that specify the key parameters leading to a near Zero Energy Building from a certification approach.

Learners will be able to understand and to communicate to others the key parameters defining a near Zero Energy Building on a national level.

Learners will become able to design a near Zero Energy Building based on the above mentioned parameters following an energy performance certification approach.

Bibliography of Session 6

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ISO 6946:2007 Building components and building elements – Thermal resistance and thermal transmittance – Calculation method

Cyprus

Cyprus Energy Service, “Thermal Insulation Guide”, 2nd edition, 2009.

Cyprus Energy Service, “National Methodology for Assessing the Energy Performance of Buildings”, 2009.

Cyprus Energy Service, “Guide on near Zero Energy Buildings”, 2014.

Greece

Technical Chamber of Greece (TEE-TCG), Technical Guidelines TEE: “Analytical national parameter specifications for calculating the energy efficiency of buildings and to issue the energy performance certificate.", 2010

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Italy

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Portugal

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ADENE – Solar shading – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE – Ventilation Systems – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

ADENE - Solar thermal systems – 10 solutions for energy efficiency (http://www.adene.pt/10solucoes-eficiencia-energetica)

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5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risk.

Risk - description	Risk Level	Risk management action
Lack of delivery of training materials by partners and complexity of developing four courses (i.e. one for each country).	Medium - High	CUT to combine material supplied in each country with own material to create four versions of the course, one for each target country. Review of relevant developed material by partners in each target country for identification of possible errors and misleading information. Hold special TCFs for WP3 in case of serious deviations. Coordinator action as required.
Poor delivery of classroom training by target country partners and trainers	Medium	Front runner countries are expected to assist the partners in the target countries and the trainers through Q&A sessions by video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low - Medium	CUT, as a university, has an extensive experience in exam preparation and will support partners in areas where particular groups of questions are not well prepared.
Excessive differences in local issues	Low	CUT will review local material and advice on changes as required.

6 COMMENTS FROM REVIEWERS

ITEM	DESCRIPTION	FURTHER NOTES
Training Module	Basic training module	
Does it meet needs of Annex 1	Yes mainly	
Does it accord with Training Essay Plan	Yes. There is a substantial focus on the on HVAC systems, which given the focus on cooling is understandable. However, it would be useful to compare and perhaps address the advanced course and whether or not there is any overlap. (NB – I have not seen the Advanced course as yet).	CUT and DTTN to discuss HVAC in both courses
General quality assessment	Good quality presentations.	
Further comments	At 319 (approximately) slides that need to be delivered in 12 hours. That is around 30 per hour, or every two minutes.	CUT should consider the timing of the training, if it will over-run then consider reducing content.
Suggested actions	CUT to discuss HVAC content with DTTN. CUT to look at amount of material and its delivery within 12 hours; especially with exercises included.	

Note: The reviewer's comments related to the basic module's material, the contents and the number of slides were taken into account and modifications were included in the final version of the Module presentations.

APPENDIX B - DESCRIPTION OF MODULE 2: ADVANCED MODULE

2 WP3 – TASK 2 - TRAINING MODULE 2 – ADVANCED MODULE DESCRIPTION

2.1 Preparation and delivery

Preparation of the course material is undertaken by Trentino Technological Cluster (DTTN) with collaboration of University of Patras (UPatras) and the Cyprus University of Technology (CUT) (in accordance with the Description of Work). DTTN prepares Chapter 1, Chapter 2, Chapter 3 and Chapter 7, UPatras prepares Chapter 4 and CUT prepares Chapter 5 and 6. The Assessment Exams are prepared by KEK.

The individual responsible for developing the module assuring also quality check are Eng. Francesco Gasperi, Head of Technical Department in Habitech, Eng. Thomas Miorin, Head of Innovation Department in Habitech and Dr. Micol Mattedi, European Projects Coordinator in Habitech.

Local issues are determined and course materials prepared by the partners in the target countries where occurs. Anyway this content does not exceed 15% of the course. Where necessary, local issues are prepared by local partners (CUT in Cyprus, KEK and UPatras in Greece, DTTN in Italy and UMinho and IST-ID in Portugal).

Delivery of the training course material to trainers is undertaken in each country by the relevant partners (in accordance with the Description of Work); in Cyprus by CUT, in Greece by KEK, in Italy by DTTN and in Portugal by UMINHO and IST-ID. After, the trainers will also deliver the courses to the trainees.

2.2 Outline of Module 2 – Advanced Module

Module 2 aims at presenting to engineers, architects, building supervisors, site managers, building auditors, government and local authorities officials involved in the regulation of energy efficient buildings the advanced concepts of nZEB design and building, including technical physic notions (like humidity, building materials, construction techniques, ventilation and the use of energy sources). It is presented also the passive use of renewable energy (e.g. passive solar gains).

This module focuses on the elaboration on various arguments of nZEB design and building, including technical focuses on principles of bioclimatic design, passive systems, building materials, renewable energy sources, construction and measurement techniques, ventilation, natural lighting and the processes of energy audit and commissioning.

The estimated duration of the training is 20 hours, divided in pre-course preparation, classroom, post-course study and exam.

This training module is coordinated, designed and planned by DTTN, with the specific collaboration of CUT and UPatras in some chapters and all the other partners where requested.

2.3 Purpose of the training

Buildings are responsible for approximately 40% of energy consumption and some 36% of the European Union's carbon dioxide (CO_2) emissions. Within the buildings sector, improvements in energy efficiency in parallel with the increased use of renewable energy technologies create important policy measures needed to reduce the European Union's energy dependency on fossil fuels and associated greenhouse gas emissions.

With the adoption of the recast EPBD in 2010 (Directive 2010/31/EU), EU Member States faced new tough challenges. Foremost among them, moving towards new and retrofit nearly-zero energy buildings by 2020 (2018 in the case of Public buildings), and the application of a cost-optimal methodology for setting minimum requirements for both the envelope and the technical systems, and also disciplining installations' controls.

Professionals who are involved in the building's design and construction sector need to deeper analyse the nZEB definition and concepts in order to start building and re-building with new concepts, minimizing the risks of unintended poor design and building energy performance (e.g. excess of humidity, increasing costs due to inefficient systems). In the module they will learn the design elements for residential and non-residential buildings in temperate climate:

- To orient the building to face the equator (or a few degrees to the East to capture the morning sun); the placement of room-types, internal doors and walls, and equipment in the house;
- To extend the building dimension along the east/west axis;
- To use the appropriate size of the windows to face the midday sun in the winter and be shaded in the summer; to minimise the windows on other sides, especially western windows;
- To erect correctly sized, latitude-specific roof overhangs or shading elements (e.g. trellises, fences, shutters, etc.);
- To use the appropriate amount and type of insulation (including radiant barriers and bulk insulation) to minimise seasonal excessive heat gain or loss;
- To use thermal mass to store excess solar energy during the winter day (which is then re-radiated during the night);
- To understand the different components of HVAC systems (types, fans, ducts, etc.);
- To know the key elements of energy audits and the commissioning process (definition, philosophy behind the process and examples));
- To get familiar with the instrumentation to perform an energy audit and verification, focusing on practical examples and learning the tools to operate properly.

This module will follow the nZEB basic module dealing with various concepts which are strictly connected with designing and planning of nZEB buildings.

2.4 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience (course, webinar, self-study or group activity). Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experiences.

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials.

Learning objectives:

- Provide clarity about the purpose of the course;
- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals;

- Establish accountability between the learner and the trainer;
- Help trainers articulate exactly the lesson in the most proper and professional way.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound.

The learning objectives of Module 2 are summarized as follows:

- To Resume and re-elaborate concepts from the basic module about nZEB and their importance to achieve the EU targets.
- To understand the nZEB philosophy and the nZEB design while following the EU Directives.
- To learn advanced concepts for a nZEB building: bioclimatic design, passive systems, and green buildings materials.
- To familiarize with systems and techniques for passive solutions (passive solar systems, natural lighting, passive systems for heating/cooling).
- To present the available renewable energy sources for nZEB (domestic and non-domestic buildings) and how to integrate them to achieve nZEB standards.
- To understand, identify and apply the knowledge besides designing a nZEB building (air tightness, ventilation and moisture movement).
- To learn strategies for energy audits and energy performance certification.
- To focus on the dimensioned installations on nZEB buildings.
- To participate to a practical workshop on the instruments to perform an energy audit and verifications.

The trainees, after completing the course, are able to demonstrate a better and deep knowledge on the most important aspects of nZEB buildings, how to manage with technical notions and specific aspects of bioclimatic design, technical physical notions (e.g. humidity, building materials, ventilation), use of RES and the passive use of RES (e.g. passive solar gains).

PowerPoint slides are supported by accurate bibliography: reading documents recommended to be studied before and after attending the course and additional material is presented.

2.5 Learning audience – trainers and trainees – qualifications and experience

The trainers and trainees will be those building professionals involved in the design and construction of buildings, as well as those involved in the building regulation system. Professions will include architects, engineers, building supervisors, site managers, building auditors and building control professionals. Government and local authority officials involved in the regulation of energy efficient buildings will also be included.

The trainers should be members of a relevant construction profession and have extensive experience of practice in the design and construction of buildings, preferably on energy efficient buildings. Experience on supervision of staff and previous experience in delivering training would also be useful.

The trainees include the building professionals described above, but with any number of years' experience from graduation through to senior company Directors.

3 STRUCTURE OF MODULE 2 – ADVANCED MODULE

The estimated duration of the training is 20 hours and the main structure of the training course should be as follows:

- **Preparation** – involving an on-line introduction and background reading; resume of the main contents of the basic module to be sure that trainees have assimilated them (the approximate duration is 1 hour).
- **Class based training** – involving delivery by a trainer of the main components of the training. The delivery will be given by the approved trainer in modules split in 2 or 3-hours sessions to between 10 and 20 trainees at each session. The approximate duration of the classroom training (included the workshop) will be about 16 hours.
- **Post classroom based training, self-learning and exam preparation**. The training will include on-line consultation of the contents of the e-learning platform and self-assessment. Whenever possible, videos and FAQ guides will be provided to help consolidating the delivered topics. The approximate duration of this part of the training will be 2 hour.
- **Competence assessment** - will be delivered through a one hour written exam after the completion of the training course and will be structured in a combination of multiple-choice questions, short essay and calculation questions. 1 hour should be allocated to complete the exam.

3.1 Time Allocation of Module 2

It is foreseen and desirable to have 16 hours of class room training, distributed amongst the following:

- Session 1 – Introduction: nZEB philosophy and practical aspects associated with nZEB design
- Session 2 – Bioclimatic design, passive systems for heating/cooling, low energy consumption buildings
- Session 3 – Greenbuildings materials, natural ventilation, low-E, thermal insulation
- Session 4 – Passive solar systems, natural lighting, RES
- Session 5 – HVAC systems
- Session 6 – Energy audits and commissioning process
- Session 7 – Instrumentation to perform an energy audit and verifications
- Exam.

3.2 Course reading material

A number of documents are indicated as necessary (pre-course and post-course) and additional reading material related with thermal comfort is pointed out.

Pre-classroom

Richard Hyde, “Bioclimatic Housing: Innovative Designs for Warm Climates”, 2008

Jarek Kurnitski (ed.), “Cost Optimal and Nearly Zero-Energy Buildings (nZEB): Definitions, Calculation Principles and Case Studies”, 2013.

Mazzucchelli Sergio, “Edifici a energia quasi zero. Materiali, tecnologie e strategie progettuali per involucri e impianti innovativi ad alte prestazioni”, 2013

Iannaccone G., Imperadori M., Masera G., “Smart-ECO Buildings Towards 2020/2030. Innovative Technologies for Resource Efficient Buildings”, 2014

David Bainbridge, Ken Haggard, “Passive Solar Architecture: Heating, Cooling, Ventilation, Daylighting and More Using Natural Flows”, 2011

Michael J. Crosbie, Steven Winter, “The Passive Solar Design and Construction Handbook”, 1998

Robert McDowall, “Fundamentals of HVAC Systems: SI Edition”, 2007

Stella Papasavva, Vasilis Fthenakis, Life Cycle Analysis Tools for 'Green' Materials and Process Selection, Volume 895, 2014

Traci Rose Rider, Stacy Glass, Jessica McNaughton, Understanding Green Building Materials, 2011.

Post classroom

The post classroom study includes the following:

- Assessment standards;
- Assessment software;
- Assessment techniques;
- Best practice details.

4 CONTENT OF MODULE 2 – ADVANCED MODULE

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content will be split into seven main chapters that will be run over the entire training course duration. Each chapter will be introduced by the trainer and the connection with the learning objectives and outcomes explained. Each chapter's duration is targeted differently because it depends on the specific technical contents of each other so it will vary in timing. The course material will be delivered through PowerPoint slides which will be made available to the trainees, who will have additional notes available on the PowerPoint slides.

The sessions are described in this section:

- Session 1 – Introduction – prepared by DTTN

    3. Introduction to the topic
    4. nZEB philosophy and practical aspects associated with nZEB design
    5. Key definition of a nZEB building

- Session 2 – Bioclimatic design, passive systems for heating/cooling, low energy consumption buildings – prepared by DTTN

    3. Bioclimatic design (architecture, design)
    4. Definition of passive house and thermal comfort
    5. Solar diagrams
    6. Ventilation systems
    7. Trombe and water walls
    8. Examples of passivhaus throughout Europe

- Session 3 – Greenbuildings materials, natural ventilation, low-E – prepared by DTTN

    4. Greenbuildings materials
        1.1 Life Cycle Analysis (LCA)
        1.2 Environmental Product Declaration (EPD
        1.3 EMICODE
    5. Natural ventilation principles
        2.1 Sidewalls, ridge openings
        2.2 Curtains
        2.3 Insulation
        2.4 Heaters
    6. Low-Emissivity glass
        a. Glazing (simple, double)

- Session 4 – Passive solar systems - prepared by UPatras

    7. Definition and types
        1.2 Thermal Mass Wall
        1.3 Roof Pond System
        1.4 Sunroom
        1.5 Air collectors
        1.6 Thermosiphon
        1.7 Integrated collector storage system
        1.8 Passive solar cooling
    8. Natural lighting
        8.1. Wavelengths of Light

8.2. Daylight design
8.3. Techniques / Systems used for natural lighting enhancement

9. Renewable Technology Sources
9.1. Solar thermal systems
9.2. Photovoltaic systems (for energy production)
9.3. Small-scale wind farm
9.4. Biomass boilers and CHP
9.5. Geothermal heat pumps
9.6. Hybrid systems

- Session 5 – HVAC Systems - prepared by CUT

8. Introduction to HVAC Systems
1.1. Thermal Losses/Thermal Load
1.2. HVAC Types
1.3. HVAC System Components
1.4. HVAC Air Distribution Equipment
1.5. Fans
1.6. Ducts

- Session 6 – Energy audits and commissioning process - prepared by CUT

3. Energy Audits & Energy Performance Certification
1.1. Key elements
1.2. Measurement/Equipment
4. Commissioning nZEB projects
a. Definitions, philosophy and process
5. Dimensioned installations on nZEB

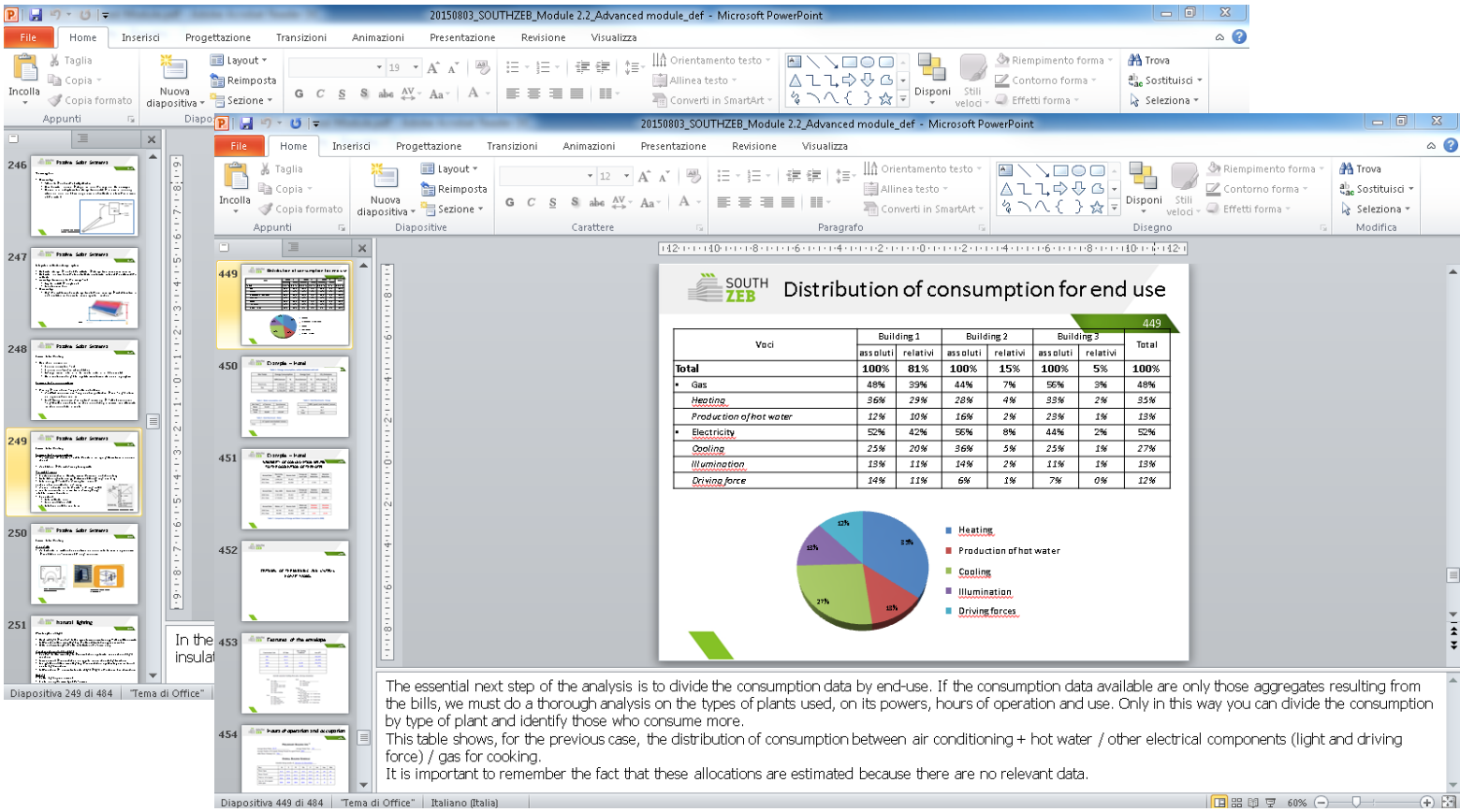
- Session 7 – Instrumentation to perform an energy audit and verifications - prepared by DTTN

1. Energy Audit
1.1 Instruments of analysis
1.2 Example of an electricity bill
1.3 Example of a gas bill
2. Features of the building and systems. How it works
3. Analysis of cost/benefit
4. On site measurements
5. Instrumentation for energy audit

- Exam

Written exam.

Most of the slides, in the notes section, have an explanation of what is the purpose of the slide and further notes related with the content are presented. This is intended to help the trainer to further develop the topic or to pinpoint the most relevant aspects that should be referred during the workshops and seminars. In other situations only tables and graphs are presented in the slides, the notes sections have the explanation of the relevant aspects that must be referred by the trainer. So, if the trainer wants to further develop the content of the slide can easily search for the document (**Figure 1**).



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Total	**100%**	**81%**	**100%**	**15%**	**100%**	**5%**	**100%**
• Gas	48%	39%	44%	7%	56%	3%	48%
Heating	*36%*	*29%*	*28%*	*4%*	*33%*	*2%*	*35%*
Production of hot water	*12%*	*10%*	*16%*	*2%*	*23%*	*1%*	*13%*
• Electricity	52%	42%	56%	8%	44%	2%	52%
Cooling	*25%*	*20%*	*36%*	*5%*	*25%*	*1%*	*27%*
Illumination	*13%*	*11%*	*14%*	*2%*	*11%*	*1%*	*13%*
Driving force	*14%*	*11%*	*6%*	*1%*	*7%*	*0%*	*12%*

Figure 3 - Screenshot of two slides showing the slide notes

At the end of the session a list of bibliographic references are presented (**Figure 2**), the trainees can further develop their training through the study of the documents listed.

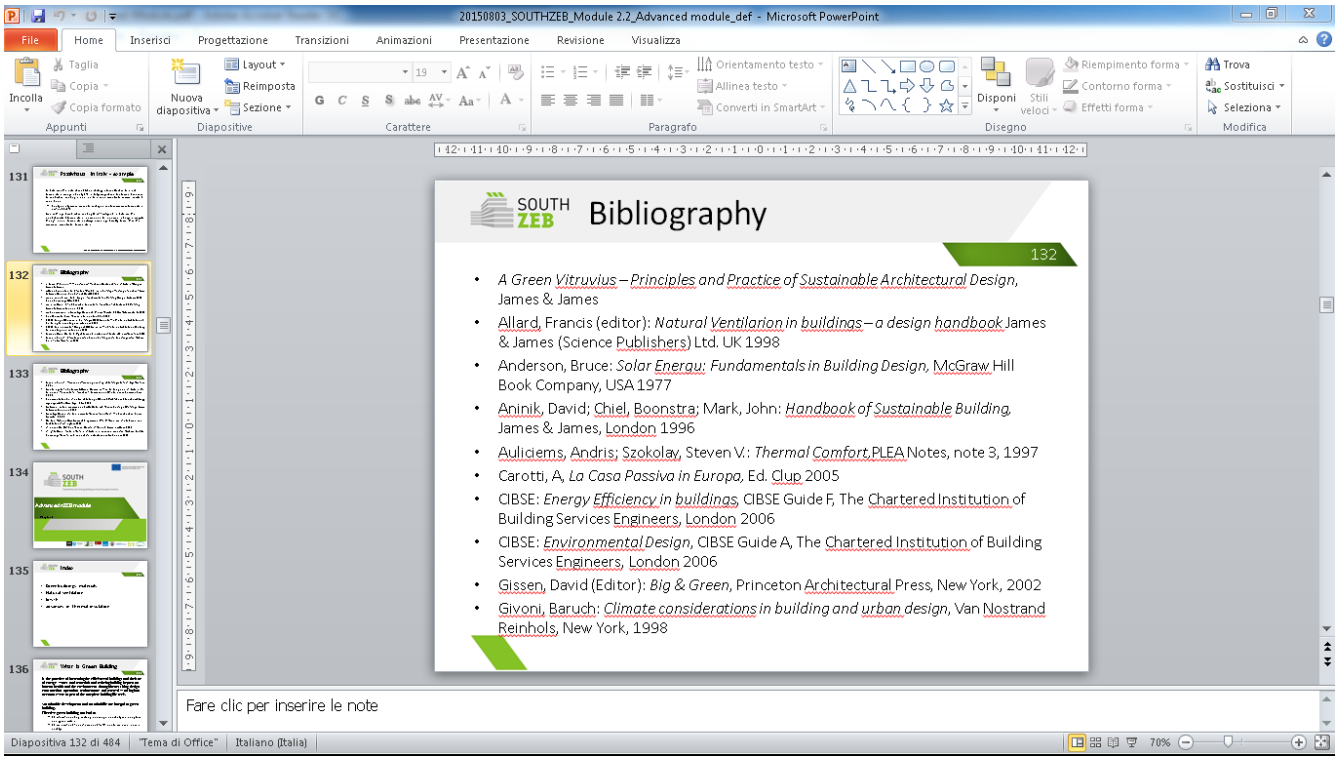

Figure 4 - Screenshot of a slide showing the bibliography of the session

4.1 Session 1: Introduction

Learning objectives of Session 1 - Introduction

The learning objectives of Session 1 are as follows:

- To give an introduction of the topic, resuming the principal contents exposed in the basic module.
- To propose the principal aspects of the nZEB philosophy and nZEB design

Content of Session 1 - Introduction

The first session of the training module addresses the basics of the envelope of the building, in particular the following:

- Vertical and horizontal structural building elements
- Doors/windows and glazing
- Shading systems
- Insulation materials

Other few slides give the main concepts and definitions of an HVAC system.

Learning outcomes of Session 1

The outcomes from Session 1 will be as follows:

- Knowledge and competence of the main concepts of nZEB philosophy;
- Knowledge of the characteristics of nZEB buildings;
- Knowledge of what is an HVAC systems and the main concepts;

Bibliography of Session 1

Kurnitski J., Buso T., Corgnati S.P., Derjanecz A., Litiu A., "nZEB definitions in Europe", REHVA Journal – March 2014 – http://www.nezeh.eu/assets/media/PDF/REHVA_nZEB_definitions_in_Europe51.pdf

Javad Khazaii, Energy-Efficient HVAC Design: An Essential Guide for Sustainable Building, 2014

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Ajla Aksamija, Sustainable Facades: Design Methods for High-Performance Building Envelopes, 2013

Alexander V. Dimitrov, Energy Modeling and Computations in the Building Envelope, 2015

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Busa Lucia, Tecnologie di involucro, in "Tecnologia dell'Architettura. Creatività e innovazione nella ricerca", a cura di Maria Antonetta Esposito, 2006

Lovell Jenny, Building Envelopes: An Integrated Approach, 2010

4.2 Session 2: Bioclimatic design, passive systems for heating/cooling, low energy consumption buildings

Learning objectives of Session 2

The learning objectives of Session 2 are as follows:

- To learn principles and concepts of the bioclimatic design.
- To know the definition of specific terms and concepts related to passive systems.

Content of Session 2

The presentation of Session 2 explains the principles of the concept of bioclimatic design, analysing the general considerations, strategies and key concepts: shape factor, volumetric. Orientation, solar exposure and protection, space distribution and surroundings.

The concept of "Passive House" is analysed, following the definitions of the standard established in 1995 and then verifying the aspects of the Passive Design method, which is the key element to sustainable buildings and in particular referred to nZEB buildings.

The most important bioclimatic architectural elements (called also "passive systems") are defined and explained:

- Captor system
- Inertia system

- Ventilation system and air treatment

The orientation of the building following the orientation of the sun is also an important requirement of the design process and that is needed to be taken into consideration when designing a nZEB building. From this point a specific section concerning solar diagrams and their use is deeply presented.

Some specific focuses are presented on the ventilation systems, the Trombe walls and the Water walls.

Finally, the role of the green roofs and of the vegetation is presented.

At the end of the section a specific part is reserved to the definition of Passivhaus in the South of Europe, presenting some examples in Portugal and Italy.

Learning outcomes of Session 2

The outcomes from Session 2 will be as follows:

- Knowledge of the definition of specific concepts connected to passive systems;
- Knowledge of the basic principles of bioclimatic design.

Bibliography of Session 2

A Green Vitruvius – Principles and Practice of Sustainable Architectural Design, James & James

Allard, Francis (editor): Natural Ventilation in buildings – a design handbook James & James (Science Publishers) Ltd. UK 1998

Anderson, Bruce: Solar Energy: Fundamentals in Building Design, McGraw Hill Book Company, USA 1977

Aninik, David; Chiel, Boonstra; Mark, John: Handbook of Sustainable Building, James & James, London 1996

Auliciems, Andris; Szokolay, Steven V.: Thermal Comfort, PLEA Notes, note 3, 1997

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Gissen, David (Editor): Big & Green, Princeton Architectural Press, New York, 2002

Givoni, Baruch: Climate considerations in building and urban design, Van Nostrand Reinhols, New York, 1998

Givoni, Baruch: Passive and low energy cooling of buildings, John Wiley, New York, 1994

Goulding, John R.; Lewis, J. Owen; Steemers, Theo C.: Energy in Architecture: the European Passive Solar Handbook, Commission of the European Communities, 1992

Liddament, Martin W.: A Guide to Energy Efficient Ventilation, International Energy Agency, AIVC, Oscar Fager Plc, 1996

Santamouris, M.; Asimakopoulis, D. (Editors): Passive Cooling of Buildings, James & James, London, 1996

Szokolay, Steven V.: Environmental Science Handbook, The Construction Press, Lancaster 1980

United Nations Development Programme, World Resources, World Resources Institute, Washington, 2000

- Valeria Vitale, Alessandra Vocaturo (2012), Applicazioni del diagramma solare, presentation

Wienke, U.: L'edificio Passivo, Standard, Requisiti, Esempi, Allinea 2002

Wright, David: Natural Solar Architecture: a passive primer, Van Nostrand Reinhold Company, New York, Cincinnati, Toronto, London, Melbourne, 1978

Passive Home Training Module for Architects and Planners – Passive-On project

4.3 Session 3: Greenbuildings materials, natural ventilation, low-E

Learning objectives of Session 3

The learning objectives of Session 3 are as follows:

- To understand the concept at the basis of the use of green materials,
- To understand the LCA system in detail
- To have knowledge of the principles of natural ventilation and the low-emissivity glass

Content of Session 3

Session 3 of the training module addresses specific contents related to:

- Greenbuildings materials,
- the LCA system in detail,
- the principle of the natural ventilation:
    - sidewalls, ridge openings, curtains, insulation, heaters
- Low-Emissivity glass (simple and double use)

Learning outcomes of Session 3

The outcomes from this session are related with the understanding of the potentiality and the benefit of the use of greenbuilding materials and their LCA. Moreover, the detailed description of the natural ventilation concept will be very useful for future designer professionals.

Bibliography of Session 3

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Natural Ventilation in Buildings, Tony Rofail, NEERG seminar, 31 Aug 2006, Windtech Consultants

Natural Ventilation – capabilities and limitations (comfort and energy efficiency in domestic dwellings), ATA Melbourne Branch presentation, April 2008, Jim Lambert

Rubini Luca, Bioedilizia, quaderni del manuale dell'ingegnere, 2014

www.educationcenter.ppg.com

www.lowenergyhouse.com.

4.4 Session 4: Passive solar systems

Learning objectives of Session 4

The learning objectives of Session 4 are as follows:

- To be able to understand the concept of passive systems, in particular related to passive solar systems and to related themes:
    - Thermal Mass Wall
    - Roof Pond System
    - Sunrooms
    - Air collectors
    - Thermosiphon
    - Integrated collector storage systems
    - Passive Solar Cooling
- To explore the concept of natural lighting, in particular:
    - Wavelengths of Light
    - The effects of light in the body
    - Daylighting in the office, focusing on the design and systems
    - Techniques used for natural lighting enhancement (windows, skylights, light shelves, light tubes, prismatic panels, etc.)
- To show the main technologies that exploit the renewable sources:

Content of Session 4

The passive solar system is called the design process in which windows, walls and floors are made to collect, store and distribute solar energy in the form of heat in the winter and reject solar heat in the summer. The use of the term “passive” is due to the fact that unlike active solar heating systems, it does not involve the use of mechanical and electrical devices.

The key to design a passive solar building is to best take advantage of the local climate performing an accurate site analysis. Elements to be considered include:

- window placement and size,
- glazing type,
- thermal insulation,
- thermal mass
- shading
- use of Renewable energy and technology sources
    - Solar thermal systems

- Photovoltaic systems
- Small-scale wind farm
- Biomass and boilers
- Geothermal heat pumps
- Hybrid systems

Learning outcomes of Session 4

The outcomes of this session for learners will be an understanding on how to define a passive solar system in each of its components. Learners will also be able to know the different RES and their use.

Bibliography of Session 4

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4.5 Session 5: HVAC Systems

Learning objectives of Session 5

The learning objectives of Session 5 are as follows:

- To understand the basics of Heating, Ventilation and Air Conditioning (HVAC) systems;
- To be able to identify the different components of HVAC systems.
- To be able to focus on fans and ducts of HVAC systems
- To be able to understand the different concepts of thermal losses and thermal load.

Content of Session 5

Session 5 will address the notion of HVAC systems, in particular:

- Thermal losses and thermal load
- HVAC systems and its components
  - Air cooled chillers
  - Water cooled chillers
  - Air Handling Systems
  - Filters
  - Duct heaters
  - Fan coil units
- HVAC Air distribution equipment
- Focus on fans and ducts design (construction and performances)

This session is well technical detailed with many examples of HVAC components.

Learning outcomes of Session 5

HVAC is an important part of residential structures such as single family homes, apartment buildings or hotels, where safe and healthy building conditions are regulated with respect to temperature and humidity, using fresh air from outdoors.

Learners will understand the three central functions of heating, ventilation, and air conditioning that are interrelated, especially with the need to provide thermal comfort and acceptable indoor air quality within reasonable installation, operation, and maintenance costs. HVAC systems can provide ventilation, reduce air infiltration, and maintain pressure relationships between spaces.

Bibliography of Session 5

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Jan F. Kreider, Peter S. Curtiss and Ari Rabl. Heating and Cooling of Buildings Design for Efficiency. CRC Press Taylor & Francis Group.

T. D. Eastop & J. M. Gasiorek. Air Conditioning through Worked Examples. Longmans.

Frank E. Beaty, Jr. Sourcebook of HVAC Specifications. McGraw Hill.

Nils R. Grimm, Robert C. Rosaler. Handbook of HVAC Design. McGraw Hill.

4.6 Session 6: Energy audits and commissioning process

Learning objectives of Session 6

The learning objectives of Session 6 are as follows:

- To be able to know the process of energy audit, in particular referring to the regulations and standards;
- To be able to identify the different process elements of an energy audit;
- To know which is the correct equipment in order to carry on an inspection;
- To understand the different step of a commissioning process, including benefits and costs.

Content of Session 6

In this session, the two definition of the process of "energy audit" and "commissioning" are identified and explained, going into specific details:

- Energy Audit is an inspection, survey and analysis of energy flows, for energy conservation in a building, process or system to reduce the amount of energy input into the system without negatively affecting the outputs.
    - Role of the Energy Auditor
    - Scope and elements of the process
    - General equipment
- The Commissioning Process aims to assure that all systems and components of a building or industrial plant are designed, installed, tested, operated, and maintained according to the operational requirements of the owner or final client.

Learning outcomes of Session 6

The outcomes from this session are related with the knowledge of these two fundamental processes. The learners should have understood the main issues of an audit process are:

- The analysis of building and utility data, including study of the installed equipment and analysis of energy bills;
- The survey of the real operating conditions;
- The understanding of the building behavior and of the interactions with weather, occupancy and operating schedules;
- The selection and the evaluation of energy conservation measures;
- The estimation of energy saving potential;
- The identification of customer concerns and needs.

Learners should also have learnt the importance of the commissioning process as well: it is the process of planning, documenting, scheduling, testing, adjusting and verifying the systems. The goal is to enhance the quality of the delivered project by focusing the design and construction team on the owner's goals for a functional and energy efficient building.

Bibliography of Session 6

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EN 16247-2:2012 Energy Audits – Part 2: Buildings

EN 16247-3:2012 Energy Audits – Part 3: Processes

ISO 50002:2014. Energy audits -- Requirements with guidance for use

ASHRAE. Procedures For Commercial Building Energy Audits. 2011. 2nd edition. ASHRAE.

Canadian Industry Program for Energy Conservation. Energy Savings Toolbox – An Energy Audit Manual and Tool (http://www.nrcan.gc.ca/sites/oee.nrcan.gc.ca/files/files/pdf/energy-audit-manual-and-tool.pdf)

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BCA, New Construction Building Commissioning Best Practice, 2011

Paul C. Tseng, Commissioning Sustainable Buildings, September 2005, ASHRAE Journal.

ASHRAE, Commissioning Process for Buildings and Systems, 2012.

4.7 Session 7: Instrumentation to perform an energy audit and verifications

Learning objectives of Session 7

The learning objectives of Session 7 are:

- To analyse in detail the correct instrumentation to perform an energy audit and verifications;
- To be able to read an electricity and a gas bill (showing examples);
- To understand the practical example of filled tables taken from the model “ASHRAE Energy Audit”;
- To do a correct analysis of costs and benefits;
- To identify the instruments to implement an energy audit.

Content of Session 7

In session 7 an overview of the energy audit process is presented:

- Instruments of analysis
- Example of an electricity bill
- Example of a gas bill
- Analysis of costs and benefits
- On site measurement
- Focus on the instrumentation to perform an energy audit

Learning outcomes of Session 7

The outcomes from this session are related with the understanding of the energy audit process, in particular the objective of the phase of onsite visit is the inspection of the building in function of the objectives of diagnosis and the onsite data collection to help initial evaluations.

Learners will show a good understanding of the documentation shown during the presentation and should be able to analyse the contents correctly.

Learners will be able to explain the thermal comfort monitoring and measurements procedures, identify the

Bibliography of Session 7

Model for energy audits based on "Energy Audit ASHRAE – Level I"

Application to case studies of LEED © for existing buildings (LEED-EB: O & M): energy savings achieved and possibility 'of use of Energy Performance Contract (EPC)

Energy Audit Protocol - Energy and Process Assessment Protocol

Sonal Desai, Handbook of Energy Audit, 2015

Krarti Moncef, Energy Audit of Building Systems. An engineering approach, 2001

Dall'O' Giuliano, Green Energy Audit of Buildings: A Guide for a Sustainable Energy Audit of Buildings, 2013

Y. P. Abbi, Shashank Jain, Handbook on Energy Audit and Environment Management, 2006

Mazzarella, Pierrà, Efficienza Energetica attraverso la Diagnosi e il Servizio Energia negli Edifici – Linee Guida, 2013

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Energy Audit Instrumentation, presentation during the 35th convention of the Association of Energy Engineers https://www.aeecenter.org/files/certification/International/SI CEM Fast Track Online Workbook Files/Session 1/1-3 Instrumention SI CEMFastTrack 03 26 12.pdf

Energy Audit Equipment, www.energyauditingblog.com/energy-audit-equipment/

5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risk.

Risk - description	Risk Level	Risk management action
Poor delivery of classroom training by target country partners and trainers	Medium	DTTN can assist partners and trainers for this specific module through specific Q&A sessions by skype calling or video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low-Medium	DTTN will monitor rates and amend course contents in order to support areas where particular groups are not well prepared.
Excessive differences in local issues	Low	DTTN will review local material and will advise on changes as required.

6 COMMENTS FROM EXTERNAL REVIEWER

ITEM	DESCRIPTION	FURTHER NOTES
Training Module	Advanced training module	
Does it meet needs of Annex 1	Yes the module meets requirements	
Does it accord with Training Essay Plan	Yes the sessions set out are in accordance with the plan	
General quality assessment	The module covers a substantial range of subjects and for this reason the level of detail appears to be variable. However, the overall quality is good.	Module updates have been made
Further comments	None	
Suggested actions	Assess the content of the sessions so that they are more symmetrical	Module updates have been made

Note: The reviewer's comments related to the basic module's material, the contents and the number of slides was taken into account and modifications were included in the final version of the Module presentations.

APPENDIX C - DESCRIPTION OF MODULE 3: BUILDING THERMAL PERFORMANCE

2 WP3 – TASK 2 - TRAINING MODULE 3 – DESCRIPTION

2.1 Outline of module 3

Module 3 focusses on the increasingly important topic of building fabric performance. It presents the drivers for, and benefit of, improving building fabric performance, as well as highlighting the risks that poor building fabric design and/or construction can present. It also addresses how building fabric performance can be assessed including information on the evaluation and calculation of thermal performance. This is reinforced via a number of practical exercises to ensure attendees have a fundamental understanding of the theory comprising key building performance issues. Sub-modules will include:

- Subject overview
- U-Values
- Thermal bridging
- Impacts of building fabric
- Fabric performance and ZEBs
- On-site issues
- Commissioning of building fabric
- Independent accredited thermal detail sets

This training module has been coordinated, designed and planned by BRE with additional input from the partner countries (Cyprus, Greece, Italy and Portugal) to ensure that the material relates to country specific issues and needs e.g. local policies, procedures and allowing for local regulations, traditions and opportunities to be fully explained.

The estimated training duration is17 hours. It is addressing the needs of engineers, architect, building developers and municipality employees.

2.2 Purpose of the training

Improving building fabric performance is a key contributor to creating more efficient buildings by helping reduce their energy consumption and the resulting production of harmful emissions. Equally importantly it can also impact positively upon occupant thermal comfort, productivity and health. The purpose of the training is to highlight the growing importance of the need to consider thermal performance in building design and construction, and introduce attendees to the principles and theory of fabric design including its practical assessment. Attendees will thereafter be apply to apply their learning to their profession enabling them to be more aware of the issues affecting improved fabric performance, and enabling them to use this knowledge to create buildings which are healthier, more energy efficient and better performing.

In order to get a building to a level where it can be considered an nZEB requires careful consideration of thermal performance. This requires an understanding of the relevant construction practices, regulations and technical theory which relate to thermal performance. This includes but is not limited to:

- The importance of building regulations as a driver for change
- An understanding of thermal transmittance (U-values) and thermal bridging and their relation to thermal performance
- The impacts of poor thermally performing buildings in relation to energy costs, carbon emissions, internal environment, potential structural damage, and occupant health
- The importance of ensuring that the as-constructed thermal performance of a building meets the design specifications.

This training module will cover all of these topics, and more, to ensure that the trainee is well equipped with the necessary knowledge and understanding of thermal performance which can then be translated into their area of expertise and the further built environment. The learning outcomes and module content sections later in this document will contain more detail on the specifics of what the trainee will learn during the course.

2.3 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience, such as a course, webinar, self-study or group activity. Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experience(s).

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials. Learning objectives:

- Provide clarity about the purpose of the course.
- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals.
- Establish accountability between the learner and the instructor.
- Help trainers articulate exactly what they want participants to do by the end of the training.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound.

The learning objectives of Module 10 are as follows (specific):

- To understand how improvements to fabric performance will contribute to near ZEBs, EPBD and global greenhouse gas targets
- To understand how changes to local building regulations and codes lead can be used as a lever for developers and designers to consider thermal performance in greater detail.
- To understand the role of calculating and using thermal transmittance values (U-values) in satisfying the requirements of the EPBD and national building regulations (including local context in the partner countries, Cyprus, Greece, Italy and Portugal) as well as how they relate to thermal performance generally.
- To understand the role of calculating and using thermal bridging values in satisfying the requirements of the EPBD and national building regulations (including Cyprus, Greece, Italy and Portugal) as well as how they relate to thermal performance generally.

- To understand and be able to explain the impacts that poor thermally performing buildings have on energy consumption, running costs, carbon footprint, occupant satisfaction and health.
- To be able to identify the key on-site risks which could jeopardise optimum thermal performance in relation to buildability and workmanship
- To understand where thermal bridging can occur, how to identify such locations and be able to investigate and specify remedial measures for poorly constructed details.
- To understand the importance of commissioning in ensuring that new building fabric and systems perform as they should according to the design specification. As well as this, trainees will develop awareness and understanding of the different testing methods which can be used to ensure this.
- To understand the role of local, approved thermal details schemes plays in local building regulations and in leading to better performing buildings. Also, to introduce third party independently accredited schemes.

Measureable – Upon completing the course attendees will be able to identify the parameters which effect thermal performance and how they relate to achieving nearly ZEBs. Attendees will also be able to perform calculations of thermal transmittance (U-values) and thermal bridging.

Reasonable – Attendees will be able to address the implementation of nZEB development within their own work, taking into consideration the requirements of optimal thermal performance. They will also be able to explain to colleagues and third parties about the different topics related to thermal performance.

Time-bound – learning will be completed after the training and completion of course reading.

2.4 Learning audience – trainers and trainees – qualifications and experience

The trainees should be building professionals involved in the development, design and construction of buildings, as well as those involved in the building regulation system or building inspection. For example, suitable professions will include architects, architectural technologists, engineers (mechanical and structural), building supervisors, site managers, clerk-of-works and building control professionals. Government and local authority officials involved in the regulation of near zero energy buildings will also be included. The trainees could have any number of years' experience from graduation through to senior company Directors.

The trainers will be members of a relevant construction profession and have at least five years' experience in practice of the design and construction of near zero energy buildings including experience in the course topics.

3 STRUCTURE OF MODULE 3

The structure of the 20 hour training course is as follows:

- Preparation – involving an on-line introduction and background reading, the approximate duration is 4 hours.
- Class based training – involving delivery by a trainer of the main components of the training. The delivery will be given by the trainer to between 10 and 20 trainees at each session. The approximate duration of the classroom training is 8 hours.
- Post classroom based training, self-learning and exam preparation. The training will include on-line/video from actual buildings to demonstrate good and bad practice. The approximate duration of this part of the training is 5 hours. Attendees will also need to dedicate approximately 2 hours to prepare for the competency assessment. The duration of the post classroom training, self-learning and exam preparation is therefore approximately 7 hours in total.
- Competence assessment – this will be delivered through a one hour written assessment and will involve a multiple-choice exam. . The assessment will take 1 hour to complete.

3.1 Course reading material

Pre-classroom

A number of papers are provided in relation to thermal bridging and building energy performance.

Thermal bridges in the EPBD context http://www.asiepi.eu/wp-4-thermal-bridges.html

Schock Isokorb – Solutions to prevent thermal bridging (section 1 & 2): http://www.schock-us.com/upload/files/download/Design_Guide_Schoeck_Isokorb_Solutions_to_Prevent_Thermal_Bridging%5B5752%5D.pdf?utm_campaign=Designguide+USA&utm_source=%2Fdesignguide&utm_medium=307

The Energy Performance of Buildings Directive: http://www.epbd-ca.eu/

BRE prepared essential prior-knowledge notes. BRE prepared material will include a PowerPoint presentation covering the following:

- Background information
- Concept
- Impact.

UK:

Regulatory vehicles and approved thermal details schemes: Department of the Environment, Community and Local Government

- Acceptable Construction Details

Scottish Building Standards Division

- Accredited Construction Details

Independent / 3rd Party thermal details schemes:

BRE Certified Thermal Details and Products scheme website – "The importance of thermal bridging' section: http://www.bre.co.uk/certifiedthermalproducts

Energy Savings Trust (Enhanced Construction Details: Thermal bridging and airtightness – CE302

Constructive details resource

http://www.constructivedetails.co.uk/resources/

PARTNER COUNTRY INPUT

National building regulations/standards relevant to energy performance of buildings:

Cyprus

ΚΔΠ 33/2015 - On the Regulation of the Energy Performance of Buildings (Methodology on the Energy Assessment of Buildings) Decree 2015

ΚΔΠ 366/2013 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB) Decree 2014

Cyprus Energy Service, "Thermal Insulation Guide", 2nd edition, 2009.

Cyprus Energy Service, "Guide on near Zero Energy Buildings", 2014.

Greece

Greek Law 3851/2010 "Accelerating the Development of Renewable Energy Sources (RES) to Deal with Climate Change and Other Regulations in Topics under Authority of the Greek Ministry of Environment, Energy, and Climate Change"

Greek Law 3661/2008 "Measures to reduce energy consumption in buildings and other provisions"

Regulation for Energy Efficiency of Buildings (KENAK) issued in 2010 (Official Gazette Bulletin B' 407/09-04-2010), based on the Greek Law 3661/2008

Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B' 1387-2010 and 1413-2012

Greek Law 4122/2013 "Energy Performance of Buildings – Transposition of Directive 2010/31/EU"

Italy

Günther Gantioler (2014), *Manuale Ponti Termici* (Xella Italia ed.)

Rossella Esposti, Valentina Raisa (2009), *Igrotermia e ponti termici*, Tep

Pagliaro Marco (2011*), Risanamento energetico.Sviluppo economico e sociale e risanamento ambientale*, Maggioli editore

Attilio Carotti (a cura di) (2014), *Edifici a elevate prestazioni energetiche e acustiche. Energy Management*, Wolters Kluwer Italia

Kristian Fabbri, Cosimo Marinosci (2014), *Ponti termici negli edifici. Valutazioni, calcolo, correzioni, interventi*, Wolters Kluwer Italia

Eugenio Lequaglie, Michele Miguidi (2013), *Guida essenziale al Testo Unico dell'edilizia*, Maggioli Editore

Portugal

Portuguese Building Thermal Legislation: Decree-Law 118/2013, Decree-Law 68-A/2015, Decree Law 194/2015, Decree-Law 251/2015, Decree-Law 28/2016 and respective Mandamus and Ordinances

Efficient Construction Solutions Catalogue available at: http://www.itecons.uc.pt/catalogosce

Linear Thermal Bridges Catalogue available at: http://www.itecons.uc.pt/catalogoptl.

Post classroom

Conventions for U-value calculations (BRE Report BR 443, BRE IP 01/06 – charged publication),

EN ISO 10211 (available from national standards bodies) and thermal bridging software manuals.

FB 61 - Reducing thermal bridging at junctions when designing and installing solid wall insulation

BR 262 - Thermal insulation: avoiding risks

IP 4/13 - Advanced thermal insulation technologies in the built environment

BR 497 - Conventions for Calculating Linear Thermal Transmittance and Temperature Factors

EN ISO 6946 - Building components and building elements. Thermal resistance and thermal transmittance - Calculation methods

The post classroom study will also include a DVD/Video presentation on good and bad practice, using a number of demonstration buildings (including installation in practice and testing in practice). The post classroom study includes the following:

- Assessment standards
- Assessment software
- Best practice details.

Cyprus

ΚΔΠ 33/2015 - On the Regulation of the Energy Performance of Buildings (Methodology on the Energy Assessment of Buildings) Decree 2015

ΚΔΠ 366/2013 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB) Decree 2014

Cyprus Energy Service, “Thermal Insulation Guide”, 2nd edition, 2009.

Cyprus Energy Service, “Guide on near Zero Energy Buildings”, 2014.

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Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B’ 1387-2010 and 1413-2012

Greek Law 4122/2013 “Energy Performance of Buildings – Transposition of Directive 2010/31/EU”

Italy

Capolla Massimo (2013*), La casa a consumo zero. Indicazioni e idee per progettare casa a produzione energetica*, Maggioli editore

Alessandro Greco, Enrico QUagliarini (a cura di) (2007), *L’involucro edilizio. Una progettazione complessa*, Alinea editrice

Attilio Carotti (a cura di) (2014), *Edifici a elevate prestazioni energetiche e acustiche. Energy Management*, Wolters Kluwer Italia

Cristina Benedetti (2015), *Ponti Termici*, Bolzano University Press

Kristian Fabbri, Cosimo Marinosci (2015), *Ponti termici negli edifici e nuove UNI/TS 11300. Calcolo, correzioni e interventi*, Wolters Kluwer Italia

Portugal

Portuguese Building Thermal Legislation: Decree-Law 118/2013, Decree-Law 68-A/2015, Decree Law 194/2015, Decree-Law 251/2015, Decree-Law 28/2016 and respective Mandamus and Ordinances

Efficient Construction Solutions Catalogue available at: http://www.itecons.uc.pt/catalogosce

Linear Thermal Bridges Catalogue available at: http://www.itecons.uc.pt/catalogoptl

Corvacho, Helena. Catálogo de pontes térmicas - Nota de Informação Técnica nº 3 do LFC. 1999.

Oliveira, Rui Filipe Pereira. Construir segundo requisitos Passivhaus: modelação de pontes térmicas. Master Thesis,University of Aveiro. 2013. Available at: http://hdl.handle.net/10773/12904.

4 CONTENT OF MODULE 3

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content will be split into eight sessions that will be run over the day. Each session will be introduced by the trainer and the connection with the learning objectives and outcomes explained. The sessions will vary in timing and content. The course material will be delivered through PowerPoint slides, which will be made available to the trainees.

The sessions are described in this following sections, including relevance to the objectives and the learning outcomes.

4.1 Session 1: Subject overview

Learning objective

- To introduce attendees to the principle drivers behind improving the thermal performance of buildings, at both a global and local context.
- To highlight the importance of thermal performance in nZEB design

Content

In the first session of the training module attendees will be introduced to drivers behind improving the thermal performance of buildings at a global and local context.

The session will begin with a short introduction on the importance of high thermal performing buildings at a local context. This will involve an observation of the relevant building regulations and governmental policy within the respective country which has led to a need to consider thermal performance in greater detail. Trainees will be taught that improving thermal performance can reduce building energy consumption and greenhouse gas emissions which will be necessary for meeting EU and local government energy and environmental targets.

In this session trainees will also be taught about the different benefits that improving thermal performance can lead to. This will include the energy and environmental benefits as well as the improvements to the internal environment necessary for high occupant satisfaction and health.

The trainer will introduce two voluntary Environmental Assessment Methodologies BREEAM and LEED which are active in many countries around the world in improving overall building performance by setting out strict criteria covering many aspects including materials, insulation and energy performance. The trainer will explain that, amongst other assessment criteria, these methodologies require buildings to have high thermal performance should they wish to attain a high score. In many countries where these methodologies are used there are in fact minimum building standards which require careful consideration of thermal performance.

A discussion of the Climate Change Impacts of constructing and operating buildings will take place. For example, in the UK, the construction and operation of buildings and cities accounts for around 50% of the UK's CO_2 emissions and is thus a significant contributor to climate change. This is a similar situation in other European countries and local examples will also be presented. A large reduction in carbon emissions can be achieved simply by building and refurbishing our buildings to much higher insulation and airtightness standards.

A discussion of the different building legislation that exists in the partner countries requiring building designers to demonstrate compliance with different aspects of thermal and energy performance will also be highlighted. This will include a brief introduction to the local regulations (e.g. in the UK it is either Part L (England & Wales) or Section 6 of the Scottish Building Standards).

Learning outcomes

The outcomes from Session 1 will be as follows:

- Knowledge of the local context surrounding thermal performance
- Knowledge of the principal drivers which require careful consideration of thermal performance including those from building regulation and governmental policy
- Knowledge of common voluntary Environmental Assessment Methodologies, such as BREEAM and LEED, and how such schemes are active in promoting and improving overall building performance
- Knowledge of the Climate Change Impacts that the construction and operation of buildings have and how improving thermal performance can reduce these impacts

4.2 Session 2: Thermal Transmittance / U-Values

Learning objective

The learning objectives of Session 2 are as follows:

- To understand what U-values are and how they relate to heat flow in and out of a building
- To understand the importance of U-values in relation to reducing energy consumption and carbon emissions
- To be aware of the theory of U values, the calculations governing their calculation and to be able to perform simple U-value calculations

Content

Session 2 will look at the principle of U-values and why they are important to understand when looking at building thermal performance.

The session will begin with a definition of the U-value. The trainer will explain that the U-value is a measure of how effective a building element, such as a wall or roof, is in restricting heat loss. A lower U-value means lower levels of heat loss through that particular element. Careful consideration of the U-values of building elements will lead to higher performing buildings overall.

The importance of thermal insulation will then be discussed. Thermal insulation works by providing resistance to heat flow, i.e. low thermal conductivies, to lowering the U-values of insulated building elements, slowing the overall heat loss from/to a building. The trainer will discuss some of the different techniques and insulation materials available which can be used to improve insulation levels and to what extent they can improve thermal peformance.

The definition of thermal resistance is given and how it relates to the properties of construction materials and heat flow. As well as this the definition of surface resistance will also be given, how surface resistance values are determined and how they should be used.

The trainer will show the equation for the U-value equation then undertake some practice U-value calculations and examples using the necessary equations, procedures and principles that will have been discussed previously. Examples will include a masonry all construction and a timber frame wall construction. Other local examples will also be addressed. The trainer will also discuss how software

application (such as the BRE U-value calculator) can negate the need to calculate U-values manually, reduce errors, and speed up the process.

Learning outcomes

The outcomes from Session 2 will be as follows:

- Knowledge of the definition of the U-value and its relation to heat flow and thermal performance
- Knowledge of the relationship between thermal insulation and the U-value
- Knowledge of some common insulation materials and their properties
- Knowledge of the definition of thermal resistance as well as surface resistance
- Knowledge of how to calculate U-values using the necessary equations and procedures

4.3 Session 3: Thermal Bridging

Learning objective

The learning objectives of Session 3 are as follows:

- To understand the definition of thermal bridging and how it relates to the thermal performance of buildings
- To be able to calculate thermal bridging values in different junction details

Content

Session 3 will look at the principles of thermal bridging and why it is important when considering building energy performance and how it becomes even more critical as building regulations improve and as we move towards a low carbon economy.

The session will begin with a definition of thermal bridging and its relation to U-values and heat loss. The trainer will explain that large levels of thermal bridging lead to greater heat loss/gain and therefore increase building energy demand.

Following this the drivers behind why understanding thermal bridging is important will be discussed. The trainer will explain that new legislation and greater energy awareness lead to increased levels of insulation levels and therefore an increased importance of considering and designing out heat loss due to thermal bridging. Two key concepts will be introduced at this stage – linear thermal transmittance (psi – values), and the surface temperature factor which is used for condensation and mould growth risk assessments.

Linear thermal transmittance will then be discussed in greater detail and the trainer will explain the theory using the relevant equations. The thermal coupling coefficient and its relation to linear thermal transmittance and U-values will be explained with a masonry wall example providing greater clarity to the theory.

Further, more detailed, explanation will then be given to the previously mentioned temperature factor which is used to assess the risk of surface condensation and mould growth on any building detail. The equation for calculating said temperature factor will be presented and run through.

The trainer will then go over two important, industry recognised, reference documents – BR 497 – Conventions for Calculating Linear Thermal Transmittance and Temperature Factors and BR IP 1/06 – Assessing the Effects of Thermal Bridging at Juncitons and Around Openings, both of which provide useful imformation in relation to thermal bridging.

Software tools which can be used for modelling heat transfer through building details inlcuding the assessment of thermal bridges will be presented. Such software can be incredibly useful when it comes to determing the extent of thermal bridging within buildings and therefore depending on the results of the modelling adjustments can be made to improve the energy perfromance of the building.

Practical exercise of how to calculate thermal bridging psi-values will also take place during this session giving trainees a throrough undestanding of the processes involved. A variety of different junction details will be shown highlighting the thermal bridging in each.

Learning outcomes

The outcomes from Session 3 will be as follows:

- Knowledge of the definition of thermal bridging and its relation to heat flow and thermal performance.
- Knowledge of why it is necessary to consider the levels of thermal bridging when aiming for nZEBs
- Knowledge of how to calculate linear thermal bridging psi-values
- Knowledge of the definition of the temperature factor as well as how to calculate them and how they can be used to indicate the levels of surface condensation and mould risk
- Knowledge of key, industry recognised, reference documents – BR 497 – Conventions for Calculating Linear Thermal Transmittance and Temperature Factors and BR IP 1/06 – Assessing the Effects of Thermal Bridging at Juncitons and Around Openings
- Knowledge of available modelling software and how they can be used to determine the levels of thermal bridging in building details

4.4 Session 4: Impacts

Learning objective

- To understand and be able to describe the impacts of poorly insulated and poor thermally performing buildings.

Content

Session 4 will involve a discussion of the potential impacts of poor thermal performing buildings including its relation to:

- Internal environment – dampness (interstitial condensation and surface condensation), mould growth, building damage
- Health – allergies, illness, death
- Heating/Cooling costs – increased bills
- CO_2 emissions.

The session will begin with an overview of the impacts of poorly insulated buildings including – poor internal environment, deterioration of health, increased heating bills potentially leading to fuel poverty and an increased share of CO_2 emissions from the built environment.

The impacts of poor thermal performance on health will be discussed including:

- Respiratory disease caused by
    - Dampness
    - Mould growth
- Allergies
- Reduced productivity
- Poor mental health
- Sick building syndrome – a condition affecting building occupants e.g. office workers, typically marked by headaches and respiratory problems, attributed to unhealthy or stressful factors in the working environment such as poor ventilation

After this the concepts of interstitial and surface condensation will be discussed in greater detail. This is to do with moisture levels within a building element (interstitial condensation) such as within a cavity wall as well as on the internal surface of a building element (surface condensation). The potential problems linked with these issues will be discussed as well as the various reduction strategies on offer.

Learning outcomes

The outcomes from Session 4 will be as follows:

- Knowledge of the impacts of thermally poor performing buildings including impacts on the internal environment, health, energy costs, carbon emissions,
- Knowledge of the definition of fuel poverty and why it is an issue
- Knowledge of interstitial and surface condensation and how to avoid such issues

4.5 Session 5: Fabric Performance & ZEBs

Learning objective

- To understand the importance of high fabric performance in contributing to nZEBs, EPBD and global greenhouse gas targets.
- To understand the role building regulations play in improving fabric performance, with particular regards to U-values, thermal bridging and air infiltration levels.
- To understand how the importance of accurate fabric performance specification within building simulation and energy performance prediction tools

Content

Session 5 will involve looking at the relationship between building fabric performance and ZEBs.

The session will begin with a definition of a ZEB as defined by the EPBD and will then look at some of the key policies or actions that participating EU countries will have to adopt under the EPBD. This will include policies around Energy Performance Certificates (EPCs), inspection schemes for heating and air conditioning systems, minimum performance requirements for buildings, financial mechanisms to improve the energy efficiency of buildings.

Following this the trainer will discuss relevant local building regulations which may, for example, set minimum standards for fabric performance related specifications such as U-values, thermal bridging and air tightness.

Also included in Session 5 will be the role fabric specifications play in building simulation and energy performance prediction tools. The trainer will highlight why accuracy is important in these areas in order to produce reliable output data on things such as energy consumption and carbon emissions as well as internal environment conditions.

The final part of this session will involve a look at regulatory energy assessment models as in place within each partner country, and their use as methodologies to assess and compare the energy and environmental performance of buildings. The trainer will stress how these methodologies support the EPBD. As well as this the trainer will also discuss what these methodologies take into account and the different outputs they produce.

Learning outcomes

The outcomes from session 5 will be as follows:

- Knowledge of more of the fabric related (direct and indirect) policies that the EPBD requires participating EU countries to enact.
- Knowledge of how building regulations can improve fabric performance by setting minimum standards for things such as U-values, thermal bridging and air tightness levels.
- Knowledge of the relationship between accurate fabric specification and reliable building simulation and energy performance prediction tools results.
- Knowledge of local, EPBD based, regulatory energy performance of buildings calculation methodologies, and how they can be used to assess and compare the energy environmental performance of buildings.

4.6 Session 6: On-Site

Learning objective

- To understand the risks that poor construction and workmanship lead to in relation to fabric and thermal performance.
- To be able to explain some of the on-site best and bad practice examples which effect thermal performance.

Content

Session 6 will look at some on-site constructional issues and bad practices which can lead to reduced thermal performance. Topics covered will include buildability, workmanship, and build quality.

The session will begin with a discussion on buildability, which is the degree to which the design of a planned building facilitates its construction and utilisation. The trainer will discuss the issues that poor buildability can lead to and how best to mitigate or prevent these effects.

Following this a discussion of on-site workmanship and its importance in relation to thermal performance will be discussed. The trainer will stress that poor workmanship can compromise thermal performance. Particular focus will be on fabric constructional errors such as improper installation of insulation.

In session 6 the risks associated with poor build and workmanship will be discussed. This will include the risks associated with lower U-values and increased thermal bridging due to on-site errors.

Thermal images will be presented to trainees which will highlight the effects of best vs bad practice in relation to insulation, thermal bridging, air tightness and glazing levels. Non-thermal images will also be used to highlight other on-site bad practices such as improper installation of insulation.

The session will conclude with some best and bad practice examples from the country with which the training is being carried out in i.e. local best and bad practice examples.

Learning outcomes

The outcomes from session 6 will be as follows:

- Knowledge of the effects of poor buildability and workmanship on thermal performance
- Knowledge of some of the common workmanship issues which compromise fabric performance

4.7 Session 7: Commissioning of Building Fabric

Learning objective

- To understand the importance of building commissioning in ensuring that new building fabric and systems perform as they should according to design specification.
- To be able to explain the different testing methods which can be used to determine whether building fabric meets, exceeds, or does not meet its design specification.
- To understand how in-situ U-value measurements can be used to verify that design U-value specifications have been met.
- To be able to explain how thermography can be used as an in-situ testing method to assess the performance of building fabric.

Content

Section 7 will look at the commissioning of building fabric, a vitally important process for ensuring that new building fabric and systems perform as they should according to the design specification.

The session will begin with a discussion on some of the different testing methods which can be used to determine whether building fabric meets, exceeds, or does not meet it’s design specification including:

- In-situ U-value measurement
- Airtightness testing

- Smoke tests to investigate high-leak areas

- Thermal imaging
  - Identify areas of missing insualtion, air movement and other significant thermal bridges

After an initial overview of the different testing methods available the trainer will go into more detail about in situ U-value measurements. This process is used to ensure actual performance of building fabric is the same as design specification.

In the final part of this session the trainer will go over another in-situ testing method called Thermography, a type of thermographic survey. This is used to test for a variety of issues including:

- Continuity of insulation
- Significant thermal bridging
- Areas of different heat loss
- Areas affected by damp
- Air leakage or ingress

Learning outcomes

The outcomes from Session 7 will be as follows:

- Knowledge of the role that the proper commissioning of building fabric plays in ensuring optimal thermal performance.
- Knowledge of the various testing methods to ensure building fabric meets design specification

4.8 Session 8: Local, approved Thermal Details Schemes (and independently accredited schemes)

Learning objective

- To be able to explain how, locally approved thermal details schemes ensures the validity of declared thermal performance of junction details.
- To have the knowledge of the available supporting documentation which can be used to assist with understanding and assessment of thermal bridging, U-values and thermal insulation.
- To understand the benefits of independently accredited, third party certification of products (such as the BRE Certified Thermal Details and Products scheme).

Content

Session 8 will look at local, independent / accredited, thermal details schemes which provide approved or accredited thermal performance of details for use in regulatory calculations.

The trainer will begin the session with explaining why such schemes are necessary and how they are used to ensure consistency and accuracy in the declared thermal performance values of junction details. The

importance of third party certification schemes will also be introduced during which time the importance of increased accuracy of predicted building thermal and energy performance is explained.

During session 8 the trainer will also discuss some of the standards and conventions available including BRE BR 497: Conventions for calculating linear thermal transmittance and temperature factors, BRE BR 443: Conventions for U-value calculations and EN ISO 10211: Thermal bridges in building construction – Heat flows and surface temperatures – Detailed calculations.

Following this the trainer will also cover some of the available (independent) BRE esearch ans guidance documents including BRE FB 61: Reducing thermal bridging at junctions when designing and installing solid wall insulation, BRE BR 262: Thermal insulation, avoiding risks and BRE IP 4/13: Advanced thermal insulation technologies in the built environment.

By way of an example, the trainer will introduce the BRE Certified Thermal Details and Products scheme – and explain why and how it was developed, how details are assessed, including what gives it credibility and how this can ultimately assist in delivering better performing buildings. The trainer will provide an overview of the process of applying for certification of a product under the scheme.

Learning outcomes

- Knowledge of local, independent / accredited, thermal details schemes and what they are used for.
- Knowledge of BRE supporting document which are used as part of the scheme ensuring its validity and robustness.
- Knowledge of the BRE Certified Details and Products online and digital platform and what it contains.

5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risk.

Risk – description	Risk Level	Risk management action
Lack of delivery of training materials by partners and complexity of developing material suitable for each country).	High	BRE and the local country partner to combine material supplied in each country with master material to create four “local” versions of the course. Hold session on training courses at next partners meeting to resolve any issues; hold special tcfs for WP3 as required. Coordinator action as required.
Poor delivery of classroom training by target country partners and trainers	Medium	BRE can coach the partners in the target countries and the trainers through Q&A sessions by video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low - Medium	BRE and the local country partner will monitor rates and amend course content to support areas where there are specific issues.
Excessive differences in local issues	Low	BRE will review local material and advise on changes as required.

6. REVIEW ITEMS

ITEM	REVIEW	ACTION
Training Module	Thermal Performance of Building Envelope	
Does the subject matter match the training essay plan – explain reasons	Yes, it seems that the contents of the power point presentation fit perfectly	
What, if any deficiencies do you identify – explain reasons	No deficiencies were detected	
General quality assessment – please comment	The quality of the presentation is good	
Further comments		
Suggested actions for this module	Maybe a little focus on the insulation materials could be useful, in order to help the energy performance of the building	Content adapted to address comments
Please add comments on specific sections and slides here.	None	

APPENDIX D - DESCRIPTION OF MODULE 4: THERMAL COMFORT

2 WP3 – TASK 2 - TRAINING MODULE 4 – THERMAL COMFORT DESCRIPTION

2.1 Preparation and delivery

Preparation of the course material is undertaken by UMinho with collaboration of UPatras (in accordance with the Description of Work). University of Patras prepares Session 1, Session 2, Session 3, Session 4 and Session 5 in collaboration with UMinho; University of Minho prepares Session 6, Session 7 and Session 8. The Exams are prepared by KEK.

The individual responsible is Dr. Manuela Almeida an Associate Professor of UMinho. Dr. Manuela Almeida has been undertaking thermal performance of buildings, thermal and acoustical performance of buildings, rational use of energy in buildings, building conservation and rehabilitation and energy modelling for more than twenty-five years of activity at the University of Minho, where she has delivered thermal comfort training as well as scientific presentations. She will be assisted as required by Dr. Sandra Silva and Dr. Luís Bragança of UMinho Sustainable Construction Group. Dr. Manuela Almeida will also be responsible for the quality check of the material.

Local issues are determined and course materials prepared by the partners in the target countries. This content does not exceed 15% of the course. The local issues are prepared by local partners, CUT in Cyprus, KEK and UPatras in Greece, DTTN in Italy and UMinho and IST-ID in Portugal.

Delivery of the training course material to trainers is undertaken in each country by the relevant partners (in accordance with the Description of Work); in Cyprus by CUT, in Greece by KEK (Euro Training), in Italy by DTTN and in Portugal by UMINHO and IST-ID. After, the trainers will also deliver the courses to the trainees.

2.2 Outline of Module 4 – Thermal Comfort

Module 4 aims at presenting to engineers, architects, building supervisors, site managers, building auditors, government and local authorities officials involved in the regulation of energy efficient buildings the concepts of thermal comfort, its assessment methods and the way thermal comfort is related and can be achieved in energy efficient buildings and especially in nZEB.

This module focuses on the thermal environment of buildings through presentation of concepts, experimental analysis and practical exercises. It includes sections on applicable standards; the definition of thermal comfort for a human body and how to model it; factors and values that form the perception of thermal comfort; different ways of thermal comfort assessment according to international standards; optimal value ranges for thermal comfort depending on the level (category) of the requirements of the space; the users' expectations and adaptation; adaptive models of thermal comfort; acceptable range of temperatures; thermal comfort models and temperature range and their effect on energy performance of buildings; thermal comfort monitoring and measurement.

The estimated duration of the training is 20 hours, divided in pre-course preparation, classroom, post-course study and exam.

This training module is coordinated, designed and planned by UMinho, with the collaboration of UPatras, but partners from each target country (Cyprus, Greece, Italy and Portugal) developed the specific training material related with their own country. As a result, the approach changes between countries in order to allow local regulations and traditions being fully explained.

2.3 Purpose of the training

The importance of thermal comfort is increasing as people spend 90% of their time indoors. Thermal comfort is import to assure people the most adequate conditions for the development of their multiple activities inside. Creating thermal comfort conditions is essential to assure occupants' health, well-being and productivity. However, the definition of the temperature range for thermal comfort in a building has a significant impact on its thermal and energy performance, being, in many cases, one of the causes of excessive use of energy. Often, factors such as airflow and radiant temperature are disregarded in design, leading to higher energy use and occupancy dissatisfaction.

To design energy efficient and comfortable buildings it is essential to know and understand the facts and parameters that affect thermal comfort, the strategies to ensure comfort conditions as well as the human perception of it. The process of setting thermal comfort criteria, models and temperature ranges will require an evaluation of local climate conditions and the definition of sustainable design strategies to mitigate thermal discomfort as well as the identification of low energy HVAC systems to improve thermal comfort minimizing the energy consumption.

The purpose of this training module is to inform and demonstrate to professionals and other stakeholders the influence of thermal comfort on nearly zero energy buildings performance. It addresses the parameters that influence thermal comfort conditions, the conditions necessary to achieve thermal comfort and how they affect the energy efficiency of new and retrofitted buildings.

The training addresses how thermal comfort can be achieved and how its disregard can have a significant impact on energy performance of buildings. International and national standards and calculation methods are also explained in detail.

The aspects that will be covered in this training module are as follows:

- Impact of climate change on thermal comfort;
- Thermal comfort definitions and social and political understanding of the topic;
- Relationship of thermal comfort with human health, well-being and productivity and fuel poverty;
- Parameters that affect thermal comfort;
- Conditions necessary to achieve thermal comfort;
- Adaptation;
- Local thermal discomfort;
- Building regulations and standards related with thermal comfort
- Thermal comfort predictive models;
- Impact of building fabric and natural ventilation on thermal comfort and energy use;
- Range of temperatures associated with thermal comfort and their impact on buildings energy performance;

- Simulation tools;
- Thermal Comfort assessment procedures overview;
- Monitoring and evaluation of thermal comfort conditions;
- Best practice examples.

2.4 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience (course, webinar, self-study or group activity). Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experiences.

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials.

Learning objectives:

- Provide clarity about the purpose of the course;
- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals;
- Establish accountability between the learner and the instructor;
- Help trainers articulate exactly what they want participants to do by the end of the training.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound.

The learning objectives of Module 4 are as follows (specific):

- To understand the concept of thermal comfort as well as its relationship with occupants' heath, well-being and productivity and its influence in achieving energy efficient buildings;
- To understand the influence of comfort temperature ranges in satisfying the requirements of the building regulations;
- To understand and identify the parameters that affect thermal comfort conditions and the way they affect thermal sensations;
- To understand the different methodologies used to evaluate thermal comfort conditions, identify the most adequate to be used in each situation and apply them;
- To understand why and when local thermal discomfort may occur and define ways of mitigating this occurrence;
- To identify and apply the monitoring and evaluation strategies and techniques to the assessment of buildings' comfort;

- To be able to identify on site key risks and understand the requirements for good construction practice to ensure the thermal comfort conditions while minimizing energy use.

Measurable – learners, after completing the course, are able to identify the parameters that affect the thermal comfort conditions and the impact that thermal conditions on a building has in the occupants' health, well-being and productivity and how it affects the energy efficiency of the building. Learners will also be able to perform thermal comfort prediction, assessments and analysis using the most adequate methodology.

Action – learners will be able to address the implementation of nZEB development within their own work, taking into consideration the thermal comfort conditions. They will also be able to explain to clients, colleagues and other stakeholders the issues involved in thermal comfort.

Reasonable – PowerPoint slides are supported by reading documents recommended to be studied before and after attending the course and additional material is presented as bibliography in each section; the learning required is commensurate with the objective.

Time-bound – learning will be completed after the training and completion of course reading.

2.5 Learning audience – trainers and trainees – qualifications and experience

The trainers and trainees will be those building professionals involved in the design and construction of buildings, as well as those involved in the building regulation system. Professions will include engineers, architects, building supervisors, site managers and building auditors. Government and local authorities officials involved in the regulation of energy efficient buildings will also be included.

The trainers should be members of a relevant construction profession and have extensive experience, at least five years' experience in practice of the design and construction of buildings, preferably of energy efficient buildings. Experience of supervision of staff and previous experience in delivering training would also be useful.

The trainees include the building professionals described above, but with any number of years' experience from graduation through to senior company Directors.

3 STRUCTURE OF MODULE 4 – THERMAL COMFORT

The estimated duration of the training is 20 hours. The structure of the training course is as follows:

- Preparation – involving an on-line introduction and background reading; the approximate duration is 3 hours;
- Class based training – involving delivery by a trainer of the main components of the training. The delivery will be given by the approved trainer to between 20 and 30 trainees at each session. The approximate duration of the classroom training will be 10 hours;
- Post classroom based training, self-learning and exam preparation. The training will include on-line consultation of the contents of the e-learning platform and self-assessment. The approximate duration of this part of the training will be 4 hours. Attendees will also need to dedicate approximately 2 hours to prepare for the competency assessment. The duration of the post classroom training, self-learning and exam preparation is therefore approximately 6 hours in total.
- Competence assessment – this will be delivered through a one hour written exam that will involve a multiple-choice exam. The assessment will take 1 hour to complete.

3.1 Time Allocation of M4- Thermal Comfort

It is foreseen to have 10 hours of class room training, distributed per section as follows:

- Session 1 - Introduction (0.5h)
- Session 2 - Building characteristics and performance and thermal comfort conditions (0.5h)
- Session 3. Building regulation and standards (1h)
- Session 4 - Thermal comfort concepts and factors influencing thermal comfort (1.5h)
- Session 5 - Thermal Comfort and local thermal discomfort (2h)
- Session 6 - Thermal Comfort Models (1.5h)
- Session 7 - Thermal Comfort Assessment (2.5h)
- Session 8 - Examples (0.5h)
- Exam (1h).

3.2 Course reading material

A number of documents are indicated as necessary (pre-course and post-course) and additional reading material related with thermal comfort is pointed out.

Pre-classroom

Thermal comfort definitions, Standards on thermal comfort bibliography:

ASHRAE Standard 55-2004 Thermal Environmental Conditions for Human Occupancy

EN ISO 7730:2005 - Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria

EN 15251:2007 - Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

Thermal Comfort chapter, Fundamentals volume of the ASHRAE Handbook,

Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC

Bluyssen Philomena M. (2009). The Indoor Environment Handbook How to Make Buildings Healthy and Comfortable, Earthscan ltd (United Kingdom), ISBN-13: 9781844077878

Brager, G. S., de Dear, R. J. (1998). Thermal adaptation in the built environment: a literature review, Energy and Buildings 27

de Dear, R. and Brager, G.S., 1998. Developing an adaptive model of thermal comfort and preference. ASHRAE Trans., V.104(1a), pp. 145-167

Fanger, P.O., Thermal Comfort, Robert E. Krieger, Malabar, FL, 1982

Tham, K. W., Willem, H. C., Sekhar, S.C., Wyon, D. P., Wargocki, P. and Fanger, P. O. (2003) 'Temperature and ventilation effects on the work performance of office workers (study of a call center in the tropics)', in Tham, K. W., Sekhar, S.C. and Cheong, D. (eds) Proceedings of Healthy Buildings 2003, Singapore, Stallion Press, vol 3, pp280-286

National building regulations/ standards relevant to energy performance of buildings and thermal comfort:

Cyprus

Laws

N142(I)/2006 – On the Regulation of the Energy Performance of Buildings Law 2006

N30(I)/2009 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2009

N210(I)/2012 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2012

Decree Laws & Regulations

KDP 164/2009 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) Regultions 2009

KDP 39/2014 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) (Amendment) Regultions 2014

KDP 412/2009 - On the Regulation of the Energy Performance of Buildings (Energy Performance Certificates of Buildings) Decree 2009

KDP 432/2013 - On the Regulation of the Energy Performance of Buildings (Minimum Requirements on the Energy Performance of Buildings) Decree 2013

KDP 432/2013 - On the Regulation of the Energy Performance of Buildings (Recommendations for the Improvement of the Energy Performance of Buildings and Energy Performance Certificate of Buildings) Decree 2013

KDP 33/2015 - On the Regulation of the Energy Performance of Buildings (Methodology on the Energy Assessment of Buildings) Decree 2015

KDP 164/2009 – The Streets and Buildings (Energy Performance of Buildings) Regulations 2009

KDP 61/2014 – The Streets and Buildings (Energy Performance of Buildings) (Amendment) Regulations 2014

KDP 343/2013 – On the Regulation of the Energy Performance of Buildings (Methodology for the calculation of the Cost Optimal Minimum Requirements on the Energy Performance of Buildings) Decree 2013

KDP 386/2013 – On the Regulation of the Energy Performance of Buildings (Requirements on New Technical Building Systems installed in existing buildings or building units and technical systems that are replaced or upgraded) Decree 2013

KDP 366/2013 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB) Decree 2014

There are no mandatory Laws or Regulations exist in Cyprus for the performance of buildings regarding Thermal Comfort. Nevertheless, engineers use the ASHRAE 55 Standard or similar whenever in need to do so.

Greece

Greek Law 3661/2008, issued on the 19th of May 2008

Regulation for Energy Efficiency of Buildings (KENAK) issued in 2010 (Official Gazette Bulletin B' 407/09-04-2010), based on the Greek Law 3661/2008

Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B' 1387-2010 and 1413-2012

Greek Law 4122/2013 "Energy Performance of Buildings – Transposition of Directive 2010/31/EU

Italy

European Parliament and the Council of the European Parliament (2010). Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast).

UNI EN 15251:2007 - Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

D.L. 63/2013 Disposizioni urgenti per il recepimento della Direttiva 2010/31/UE del Parlamento europeo e del Consiglio del 19 maggio 2010, sulla prestazione energetica nell'edilizia per la definizione delle procedure d'infrazione avviate dalla Commissione europea, nonche' altre disposizioni in materia di coesione sociale. (13G00107) (GU Serie Generale n.130 del 5-6-2013)

ISTAT website www.istat.it

UNI EN ISO 7730- Ergonomics of the thermal environment -- Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria

ASHRAE Standard 55:2013, Thermal Environmental Conditions for Human Occupancy

EN ISO 13791 - Thermal performance of buildings. Calculation of internal temperatures of a room in summer without mechanical cooling. General criteria and validation procedures

EN ISO 13792 - Thermal performance of buildings. Calculation of internal temperatures of a room in summer without mechanical cooling. Simplified methods

Portugal

Decree-Law 118/2003, related Ordinances and Mandamus – Portuguese Energy Certification System; Regulation on the Energy Performance of Residential Buildings; Regulation on the Energy Performance of Office Buildings (sets the minimum quality of the envelope and indoor reference ambient temperatures to ensure the conditions for thermal comfort)

Matias, L., 2010. Desenvolvimento de um modelo adaptativo para a definição das condições de conforto térmico em Portugal. Coleção Teses e Programas de Investigação LNEC, TPI 65. LNEC, Lisboa

Videos:

Thermal comfort Principles: https://www.youtube.com/watch?v=aZyBdAUJlrc (Aidan Hoggard)

Post classroom

The post classroom study includes the following:

- Assessment standards;
- Assessment software;
- Assessment techniques;
- Best practice details.

Conventions for thermal comfort calculations and measurement bibliography:

ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy

ISO 7243, Hot environments - Estimation of the heat stress on working man, based on the WBGT index (wet bulb globe temperature)

ISO 7726, Ergonomics of the thermal environment - Instruments for measuring physical quantities

EN ISO 7730:2005 - Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria

ISO 7933, Ergonomics of the thermal environment - Analytical determination and interpretation of heat stress using calculation of the predicted heat strain

ISO 8996, Ergonomics of the thermal environment - Determination of metabolic rate

ISO 9920, Ergonomics of the thermal environment - Estimation of the thermal insulation and evaporative resistance of a clothing ensemble

ISO 9888, Evaluation of thermal strain by physiological measurements

ISO 10551, Ergonomics of the thermal environment - Assessment of the influence of the thermal environment using subjective judgement scales

ISO 11399, Ergonomics of the thermal environment - Principles and application of relevant International Standards

ISO TR 11079, Ergonomics of the thermal environment - Analytical determination and interpretation of cold stress using calculation of the required clothing insulation (IREQ) and the assessment of local cooling effects

EN ISO 12894, Ergonomics of the thermal environment – Medical supervision of individuals exposed to extreme hot or cold environments

ISO 13732-3, Ergonomics of the thermal environment – Touching of cold surfaces Part 3. Ergonomics data and guidance for application

EN 14058, Protective clothing garments for protection against cool environments

EN 15251, Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

ISO 15265, Ergonomics of the thermal environment – Risk assessment strategy for the prevention of stress and discomfort in thermal working conditions

ISO 15743, Ergonomics of the thermal environment - cold workplaces - risk assessment and management

EN 511, Specification for protective gloves against cold

EN 563, Safety of machinery – Temperatures of touchable surfaces – Ergonomics data to establish temperature limit values for hot surfaces

Thermal comfort software manuals: CBE Thermal Comfort Tool (http://comfort.cbe.berkeley.edu/; https://www.youtube.com/watch?v=S3KXjUuKCAQ; https://www.youtube.com/watch?v=oWjIMuS-Q8w; http://escholarship.org/uc/item/4db4q37h#page-1).

The post classroom study will also include identification of good and bad practices.

National thermal comfort calculations and measurement bibliography:

Cyprus

There is no adopted national methodology on thermal comfort calculations. The ASHRAE 55 standard (or similar) is used in cases where calculations need to be made.

Greece

Greek Regulation for the Energy Efficiency of Buildings, issued on the 9th of April 2010

Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B' 1387-2010 and 1413-2012

Italy

EN 15251, Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

EN ISO 7726 - Ergonomics of the thermal environment -- Instruments for measuring physical quantities

EN ISO 7730 - Ergonomics of the thermal environment -- Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria

EN ISO 8996 - Ergonomics of the thermal environment -- Determination of metabolic rate

EN ISO 27243 - Hot environments. Estimation of the heat stress on working man, based on the WBGT-index (wet bulb globe temperature)

EN ISO 9886 - Ergonomics -- Evaluation of thermal strain by physiological measurements

EN ISO 9920 - Ergonomics of the thermal environment -- Estimation of thermal insulation and water vapour resistance of a clothing ensemble

EN ISO 7933 - Ergonomics of the thermal environment -- Analytical determination and interpretation of heat stress using calculation of the predicted heat strain

EN 13779 - Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems

EN 12831 - Heating systems in buildings

EN 15243 - Ventilation for buildings. Calculation of room temperatures and of load and energy for buildings with room conditioning systems

EN ISO 13790 - Energy performance of buildings -- Calculation of energy use for space heating and cooling

EN 15255 - Energy performance of buildings. Sensible room cooling load calculation. General criteria and validation procedures

EN 15265 - Energy performance of buildings. Calculation of energy needs for space heating and cooling using dynamic methods. General criteria and validation procedures

EN 15203 - Energy performance of buildings — Overall energy use, CO_2 emissions and definition of energy ratings

EN ISO 13791 - Thermal performance of buildings. Calculation of internal temperatures of a room in summer without mechanical cooling. General criteria and validation procedures

EN ISO 13792 - Thermal performance of buildings. Calculation of internal temperatures of a room in summer without mechanical cooling. Simplified methods

EN 15240 - Ventilation for buildings. Energy performance of buildings. Guidelines for inspection of air-conditioning systems

EN 15239 - Ventilation for buildings. Energy performance of buildings. Guidelines for inspection of ventilation systems

EN 15378 - Heating systems in buildings. Inspection of boilers and heating systems

EN 15217 - Energy performance of buildings. Methods for expressing energy performance and for energy certification of buildings

Portugal

Matias, L., 2010. Desenvolvimento de um modelo adaptativo para a definição das condições de conforto térmico em Portugal. Coleção Teses e Programas de Investigação LNEC, TPI 65. LNEC, Lisboa

Videos:

Human comfort simulation: https://www.youtube.com/watch?v=kI02JEwwvyQ (Guy Wallis)

4 CONTENT OF MODULE 4 – THERMAL COMFORT

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content will be split into eight sessions that will be run over the entire training course duration. Each session will be introduced by the trainer and the connection with the learning objectives and outcomes explained. The sessions will vary in timing and content. The course material will be delivered through PowerPoint slides, which are made available to the trainees. The trainers have additional notes available to them on the PowerPoint slides. Additionally, there is a practical session with simulation tools and a practical session with equipment.

The sessions are described in this section, including relevance to the objectives and the learning outcomes.

The eight sessions are as follows:

- Session 1 – Introduction (0.5h) – prepared by UPatras

    6. Introduction to the topic
    7. Global context
    8. Climate change impact

- Session 2 - Building characteristics and performance and thermal comfort conditions (0.5h) - prepared by UPatras

    9. Impact of building fabric on thermal comfort and energy use
    10. Range of temperatures associated with thermal comfort and their impact on buildings energy performance
    11. Relationship of thermal comfort with human health, well-being and productivity

- Session 3 - Building regulation and standards (1h) - prepared by UPatras

    7. Social and political understanding of the topic
    8. Building regulations and standards related with thermal comfort
    9. Current building regulations and standards in the front runner countries
    10. Local context (to be prepared by partners in the target countries)
    11. Local regulations and standards (to be prepared by partners in the target countries)
    12. Local impact / issues (to be prepared by partners in the target countries)

- Session 4 - Thermal comfort concepts and factors influencing thermal comfort (1.5h) - prepared by UPatras

    10. Definition of the Thermal Comfort Concept
    11. Thermo-regulatory system
    12. Heat balance

        3.1. Sensible heat loss

        3.2. Evaporative heat loss

        3.3. Heat loss by evaporation

    13. Factors influencing thermal comfort

4.1. Metabolic rate

4.2. Thermal resistance of clothes – clothing insulation

4.3. Air temperature

4.4. Operative temperature

4.5. Air speed

4.6. Relative humidity

- Session 5 - Thermal Comfort and local thermal discomfort (2h) - prepared by UPatras

9. Adaptation

1.1. Physiological

1.2. Behavioural

1.3. Psychological

10. Global thermal comfort
11. Local thermal comfort/discomfort

3.1. Radiant asymmetry

3.2. Draught / draft

3.3. Warm or cold floors

3.4. Vertical air temperature differences

12. Effects of natural ventilation on thermal comfort
13. Thermal sensitivity of individuals, gender and age differences
14. Thermal comfort in different regions (to be prepared by partners in the target countries)

- Session 6 - Thermal Comfort Models (1.5h) - prepared by UMinho

6. Thermal comfort predictive models

1.1. EN ISO 7730 - PMV/PPD model

1.2. AHSRAE 55 model

1.3. Adaptive thermal comfort models (also to be prepared by partners in the target countries)

7. Simulation tools

- Session 7 - Thermal Comfort Assessment (2.5h) - prepared by UMinho

6. Thermal Comfort assessment procedures overview

7. Monitoring and evaluation

    2.1. Empirical approach (surveys)

    2.2. Analytical approach

    2.3. Thermal Comfort measurements. Sensors and equipment

    2.4 Practical session with equipment

- Session 8 - Examples (0.5h) - prepared by UMinho

    1. Best practice examples
    2. Local practice examples (to be prepared by partners in the target countries)

- Exam

    One-hour written exam.

For each slide of the document, in the notes section, an explanation of what is the purpose of the slide and further notes related with the content are presented. This is intended to help the trainer to further develop the topic or to pinpoint the most relevant aspects that should be referred during the workshops and seminars. In other situations, only tables and graphs are presented in the slides, the notes sections have the most relevant aspects that must be referred by the trainer and the source (presented in a more detailed manner than the one in the slide) of the figure or table is also listed. So, if the trainer wants to further develop the content of the slide can easily search for the document (**Figure 1**).

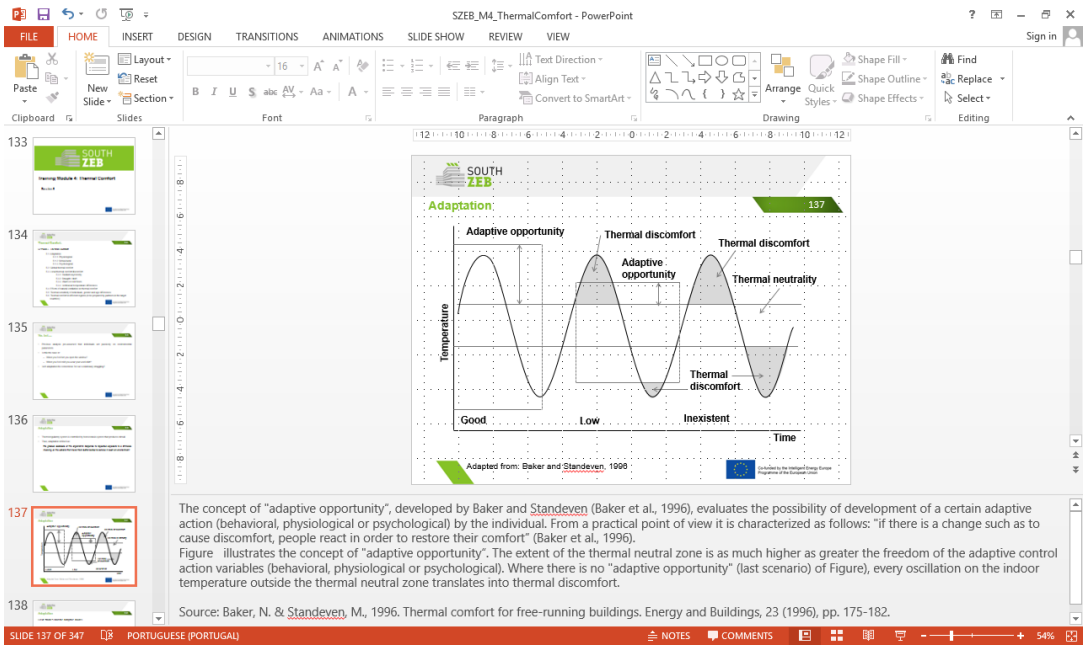

Figure 5 - Screenshot of a slide showing the slide notes

At the end of the session a list of bibliographic references are presented (**Figure 2**), the trainees can further develop their training through the study of the documents listed.

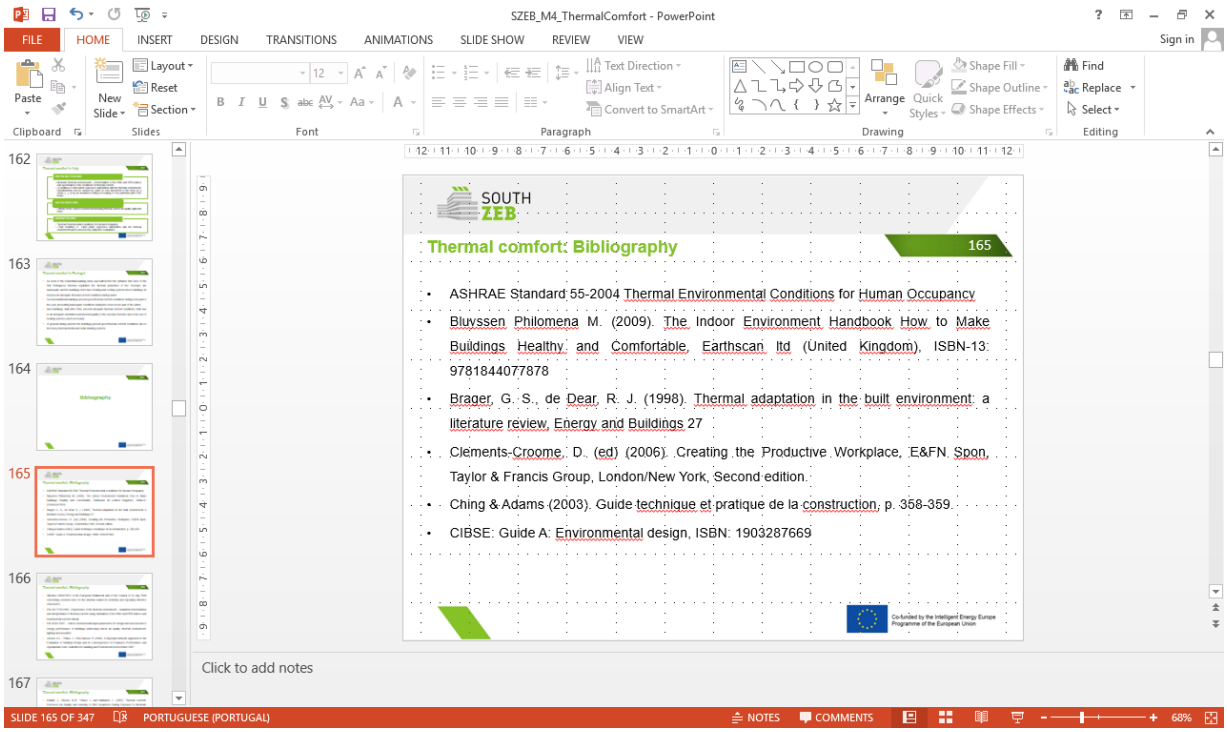

Figure 6 - Screenshot of a slide showing the bibliography of the session

4.1 Session 1: Introduction

Learning objectives of Session 1 - Introduction

The learning objectives of Session 1 are as follows:

- To understand what thermal comfort is about, its importance to each person well-being, health and productivity and its relation to nZEB.
- To understand thermodynamics and its influence on thermal comfort.

Content of Session 1 - Introduction

The first session of the training module addresses the basics of thermal comfort, in particular the following:

- Introduction to the topic
- Global context
- Climate change impact

The presentation explains that the notion of thermal comfort is subjective, but is universal and applies all over the world even that the conditions to achieve a thermally comfortable environment are different from local to local.

In this session the definition of thermal comfort is briefly presented as well the basic concepts of thermodynamics and psycrometry that are helpful to fully understand the concept of thermal comfort and how it is achieved in different conditions. It is also explained why thermal comfort has gained relevance in recent years.

The relation between thermal comfort and nZEB is presented by what is stated in the recast Directive 2010/31/EU on the Energy Performance of Buildings (EPBD), considering the local conditions and the outdoor climate. Article 1 of the EPBD – recast states that its objective is "to promote the improvement of the energy performance of buildings within the Community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness. "

As buildings are designed and retrofitted for a long period, the climate changes and their impact on thermal comfort conditions are also addressed in this session.

Session 1 is related with the global context, thus no national context is presented.

Session 1 – Introduction – estimate duration is 0.5 hours.

Summary of Session 1

Thermal comfort is the state of mind that expresses satisfaction with the thermal environment.

It is applicable to all locations.

Thermal comfort should be achieved keeping in mind environmental concerns, bearing in mind that humanity is facing unprecedented climate changes.

It is about thermodynamics and more specifically how to control temperature and moisture at a certain building space given the thermal loads.

Learning outcomes of Session 1

The outcomes from Session 1 will be as follows:

- Knowledge of EPBD-recast and the relation between thermal comfort and nZEB;
- Knowledge of the basics of thermodynamics and psycometry and the way they relate with thermal comfort;
- Knowledge of what is thermal comfort and its relation with building location and outdoor climate;
- Knowledge of how climate change affects thermal comfort.

Bibliography of Session 1

EN ISO 7730:2005 - Ergonomics of the thermal environment - Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria

Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings.

IDES-EDU. (17/04/2013). Lecture 2 – Thermal Comfort. Retrieved from: http://www.ides-edu.eu/wp-content/uploads/2013/04/2-thermal-comfort.pdf

Wikipedia. (25/09/2016). Wet-bulb temperature. Retrieved from https://en.wikipedia.org/wiki/Wet-bulb_temperature

Wikipedia. (12/09/2016). Humidity. Retrieved from https://en.wikipedia.org/wiki/Humidity

Wikipedia. (11/03/2016). Sensible heating. Retrieved from https://en.wikipedia.org/wiki/Sensible_heat

4.2 Session 2: Building characteristics and performance and thermal comfort conditions

Learning objectives of Session 2

The learning objectives of Session 2 are as follows:

- To understand how building characteristics, for example building envelope, influence building's energy performance and occupants comfort.
- To be able to identify the range of temperatures associated with thermal comfort and explain their impact on buildings' energy performance.
- To understand and explain the relation between thermal comfort, human health and productivity.

Content of Session 2

The second session of the training module addresses how building characteristics affect thermal comfort, in particular the following:

- Impact of building fabric on thermal comfort and energy use;
- Range of temperatures associated with thermal comfort and their impact on buildings energy performance;
- Relationship of thermal comfort with human health, well-being and productivity.

The presentation of Session 2 explains how the characteristics of the building, namely thermal resistance of the envelope, thermal inertia/thermal mass, but also the glazing area and its characteristics and solar shading, influence not only the energy performance of the buildings but also the thermal comfort conditions.

How heat losses are correlated with the energy needed to achieve thermal comfort is also presented in Session 2.

In Session 2, the range of temperatures associated with thermal comfort and their impact on buildings energy performance, is presented and discussed.

Thermal mass, thermal lag and thermal comfort relation is presented as well as how thermal lag affects traditions in the SouthZEB countries (culturally and construction techniques).

The notions of heat stress and discomfort are presented and also explained how they affect health, well-being and productivity (in education and in business).

Session 2 estimate duration is 0.5 hours.

Summary of Session 2

U values are related with the amount of energy that is exchanged with outdoors.

Wall to windows ratio does play a major role in achieving thermal comfort conditions.

Thermal mass determines the way outdoor thermal changes affect indoor environment.

Both U values and thermal mass affect thermal comfort and energy consumption.

Thermal comfort has a positive effect on health, well-being and productivity.

Learning outcomes of Session 2

The outcomes from Session 2 will be as follows:

- Knowledge of how the characteristics of a building affects its energy performance and its occupants thermal comfort;
- Identify the range of temperatures associated with thermal comfort;
- To be able to explain the relationship between thermal comfort and human health, well-being and productivity.

Bibliography of Session 2

European project ThermCo. (May 2009). Thermal comfort in Buildings with Low-Energy Cooling.

World Health Organization. (2012). Regional Office for Europe, Environmental burden of disease associated with inadequate housing.

4.3 Session 3: Building regulation and standards

Learning objectives of Session 3

The learning objectives of Session 3 are as follows:

- To understand the social and political context of the thermal comfort.
- To understand what is fuel poverty and how it affects society.
- To understand the social impact of the lack of thermal comfort conditions.
- To be able to identify the building regulation and standards related with thermal comfort at international and national levels.

Content of Session 3

Session 3 of the training module addresses building regulation and standards and the local context, in particular the following:

- Social and political understanding of the topic
- Building regulations and standards related with thermal comfort
- Current building regulations and standards in the front runner countries
- Local context
- Local regulations and standards
- Local impact / issues

The presentation explains that Energy poverty is a growing problem in the European Community affecting a high number of families that are not able to acclimatize their homes, leading to uncomfortable thermal conditions. In this session, the building regulations at European and national levels are presented and discussed. In Session 3 the local context, in terms of climate and building traditions, is also presented.

Session 3 estimate duration is 1.0 hours.

Cyprus

The majority of the buildings (nearly 85%) in Cyprus have been built prior the enforcement of any regulation regarding the energy performance of buildings. In addition, approximately 50% of the current building stock bear no thermal insulation whatsoever, on the building envelope. Thus, most of the buildings in Cyprus have poor characteristics with regards to the quality of indoor conditions (temperature, humidity, condensation mould growth, etc.).

In a survey performed by the National Statistics Agency of Cyprus it has been found that only 35% of the current buildings stock is equipped with a central heating system (30% have a boiler based system, while

around 5% have a heat pump installed as the thermal generation source). Moreover, only two thirds of the total floor of a residential building is heated during the winter time and that only for a few hours per day (on the average 3-5 hours per day during the afternoon and night hours). Furthermore, the dominant cooling system installed in residential buildings is that of an AC split-unit type, which is usually installed in a few of the rooms (usually the bedrooms) in a residence and only around one third of the total residence area is being cooled for a few couple of hours per day.

Despite all of the above and the poor energy performance of the buildings in Cyprus regarding indoor thermal conditions, no regulations regarding indoor temperatures and environmental conditions in buildings are in place.

Greece

In Greece approximately 26.1% of the population is affected by fuel poverty, whereas based on relevant research conducted in 2012 more than 70% of the statistical sample mentioned that they are unable to keep home warm due to financial reasons. It should also be mentioned that the Greek dwellings are the most energy consuming in the EU. The main reason for this is the building infrastructure, since the majority of the buildings were constructed before the enforcement of the thermal regulation in the buildings (app. 1980). The Greek regulation though for the Energy Efficiency of Buildings, issued on the 9th of April 2010 as well as the rest technical guidelines present the comfort limits per use of building.

Italy

The 2010/31/EU European Directive on energy performance in the building sector introduces the concept of “Nearly Zero Energy Buildings” (nZEB) in order to achieve certain efficiency objectives. Meanwhile, it left each Member State free to identify the essential steps for the implementation and diffusion of these nZEBs.

Italy had to absorb the Directive in its national law by 9th July 2012, setting up and applying minimal energy performance standards for new and existing buildings and instituting the certification of buildings’ energy performance, in order to guarantee that by 2021 all new construction will consist of “Near Zero Energy Buildings”.

The adoption was achieved after a one-year delay as an emergency measure because of a procedure for infringement against Italy: the 3rd August 2013, Law N. 90 was published in the 'Gazzetta Ufficiale', becoming effective the day after. It was later converted in Legislative Decree N.63 of 4th June 2013 “providing urgent rules for the implementation of the 2010/31/UE Parliament and Council’s EU Directive dated 19th May 2010, on energy performance in the construction industry for the rebuttal to infringement procedures started by the European Commission (....)”.

Although in Italy there is no single definition of “Near Zero Energy Building”, there are some energy efficient and passive buildings. To meet the requirements introduced by the Decree, it is essential for Public Administrations to define a strategy in order to achieve the stated objectives, and this should be defined soon given the stated deadlines.

Portugal

In Portugal 28% of the population is affected by fuel poverty and more than 20% of the population is unable to afford keeping their home adequately warm and live in buildings with humidity problems (condensation and mould).

Even with a climate that is considered mild, the Portuguese buildings do not present thermal comfort conditions, the thermal insulation of the envelope is inadequate and the buildings don't have heating and cooling systems. This is due to the fact that most of the building stock was built before the entrance into force of the first thermal regulation and building retrofitting is not a usual practice.

Indoor temperatures and ventilation rates, for winter and summer, are defined in the Portuguese thermal regulation context.

Summary of Session 3

Fuel poverty is a growing problem in the European Community.

The consequences of fuel poverty include a restricted use of heating, cold and damp homes, debts on utility bills and a reduction of household expenditure on other essential items, physical and mental health illnesses (depression, asthma and heart diseases).

EPBD related inter-standard connections, such as EN15251:2007 and EN ISO 7730:2005.

EPBD context and national standards and regulation in Cyprus, Greece, Italy and Portugal.

Outdoor climate, building traditions in Cyprus, Greece, Italy and Portugal.

Learning outcomes of Session 3

The outcomes from this session are related with social problems due to the lack of thermal comfort conditions and fuel poverty.

Learners will show an understanding of the regulation and standards at international and national levels.

Learners will be able to understand and to communicate to others the building traditions and characteristics and the way they affect thermal comfort in Cyprus, Greece, Italy and Portugal.

Bibliography of Session 3

Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC

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Nicol, S., Roys, M., Davidson, M., Summers, C., Ormandy, D., Ambrose, P. (2010). Quantifying the Cost of Poor Housing. IHS BRE Press, Watford

EN 15251:2007

Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B' 1387-2010 and 1413-2012

4.4 Session 4: Thermal Comfort Concepts and factors influencing thermal comfort

Learning objectives of Session 4

The learning objectives of Session 4 are as follows:

- To be able to identify and explain the thermal comfort concept and definitions.
- To understand and explain how the thermoregulatory system works.
- To understand the energy balance of the human body.
- To explain how heat is exchanged between human body and environment.
- To be able to identify the factors influencing thermal comfort and understand how they affect thermal comfort.
- To understand the inter-dependability of thermal comfort related quantities involved in the analysis of the thermal balance between man and the thermal environment

Content of Session 4

Session 4 of the training module addresses the definition of thermal comfort, the human thermo-regulatory system, the heat balance from human body and the factors that influence the thermal comfort:

- Definition of the Thermal Comfort Concept
- Thermo-regulatory system
- Heat balance
    - Sensible heat loss
    - Evaporative heat loss
    - Heat loss by evaporation
- Factors influencing thermal comfort
    - Metabolic rate

- Thermal resistance of clothes – clothing insulation
- Air temperature
- Operative temperature
- Air speed
- Relative humidity

Session 4 estimate duration is 1.5 hours.

The session will commence by presenting the definition of the thermal comfort concept.

The session goes on to explain to learners how the thermoregulatory system works and how heat is exchanged between the human body and environment.

The main part of the session will include the presentation of the factors influencing thermal comfort and how they affect thermal comfort.

Summary of Session 4

Humans are endothermic and homeothermic animals and their temperature is maintained within certain bounds by a complex mechanism called homeostasis.

Human body exchanges heat by both sensible and evaporative pathways.

Thermal comfort is subjected to heat balance between metabolism, heat and work.

Thermal comfort is a function of 6 inter-dependable parameters, i.e. metabolic rate, clothing insulation, air temperature, operative temperature, air velocity, relative humidity.

Learning outcomes of Session 4

The outcomes of this session for learners will be an understanding of the thermal comfort concept and definitions. Learners will be able to understand how the thermoregulatory system works, and how heat is exchanged between human body and environment. Learners will also be able to identify the factors influencing thermal comfort and understand how they affect thermal comfort.

Bibliography of Session 4

ISO 8996:2004, Ergonomics of the thermal environment -- Determination of metabolic rate

ISO 7726:2003, Ergonomics of the thermal environment - Instruments for measuring physical quantities

ISO 9920:2007, Ergonomics of the thermal environment - Estimation of the thermal insulation and evaporative resistance of a clothing ensemble

N. Kondo, N. A.S. Taylor, M. Shibasaki, K. Aoki & A. M. Muhamed. (2009). Thermoregulatory adaptation in humans and its modifying factors.

D. Goshayeshi, M. F. Shahidan, F. Khafi & E. Ehtesham. (September 2013). A review of researches about human thermal comfort in semi-outdoor spaces.

J. Kim, R. de Dear, C. Candido, H. Zhang & E. Arens. (August 2013). Gender differences in office occupant perception of indoor environmental quality (IEQ).

F. Nicol & M. Wilson. (May 2010). CRITIQUE OF CEN STANDARD EN15251: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics.

4.5 Session 5: Thermal Comfort and local thermal discomfort

Learning objectives of Session 5

The learning objectives of Session 5 are as follows:

- To be able to identify and explain the different ways of adaptation.
- To understand and explain the notion of global and local thermal comfort.
- To explain the causes of local thermal discomfort.
- To understand the effects of natural ventilation on thermal comfort and local thermal discomfort.
- To be able to understand the differences in thermal comfort perception due to the sensitivity of individuals, gender and age, cultural differences and adaptation to local conditions.

Content of Session 5

Session 5 will address the notion of thermal comfort and local thermal discomfort, in particular the following:

- Adaptation
    - Physiological
    - Behavioural
    - Psychological
- Global thermal comfort
- Local thermal comfort/discomfort
    - Radiant asymmetry
    - Draught / draft

- Warm or cold floors
- Vertical air temperature differences

- Effects of natural ventilation on thermal comfort
- Thermal sensitivity of individuals, gender and age differences
- Thermal comfort in different regions (prepared by partners in the target countries)

Session 5 estimate duration is 2.0 hours.

The session will commence by presenting the definition of adaptation and the adaptive model of thermal comfort. The concept of "adaptive opportunity“ that evaluates the possibility of development of a certain adaptive action (behavioral, physiological or psychological) by the individual is presented.

The comparison of the RP-884 adaptive model and the “static” model (based on PMV predictions) applied for HVAC buildings and to naturally ventilated buildings is presented afterwards. The three components of adaptation to indoor climate and the types of action which can be taken to adapt to the indoor climate, according to the adaptive model are then explained.

The acclimatization’s parameters, the behavioural adaptation and psychological adaptation are also explained in this session as well as is the analysis of constraints to thermal control. Later on the definition of global and local comfort is presented.

The session goes on to explain to learners the effect of natural ventilation on thermal comfort and the use of natural ventilation strategies to achieve thermal comfort.

The session includes the presentation of age and gender influence on how thermal comfort is perceived and the effect of temperature changes over time.

The session ends with the presentation of the national context of thermal comfort in Cyprus, Greece, Italy and Portugal.

Summary of Session 5

Individuals don’t act passively on environmental parameters.

Adaptation might be interpreted as the gradual diminution of the organism’s response to repeated environmental stimulation.

Adaptation includes all physiological mechanisms of acclimatization, plus all behavioral and psychological processes which building occupants undergo in order to improve the adaptation of the indoor climate to their personal or collective requirements.

The "adaptive opportunity“ evaluates the possibility of development of a certain adaptive action (behavioral, physiological or psychological) by the individual. From a practical point of view it is characterized as follows: "if there is a change such as to cause discomfort, people react in order to restore their comfort“.

In buildings with HVAC systems, the comfort temperature adjusts to EN ISO 7730 model.

In buildings without mechanical systems, the occupants adapt themselves in a way that EN ISO 7730 does not predict. In these buildings the adaptive models of EN 15251 or ASHRAE 55 are more suitable.

There are constraints to thermal control, such as constraints due to climate, to economics, to social custom or regulation, to task or occupation, to design.

Factors beyond the fundamental physics and physiology all interact with thermal perception. These can include demographics (gender, age, economic status), context (building design, building function, season, climate, semantics, social conditioning), and cognition (attitude, preference, and expectations).

Local discomfort consists of exposing parts of body to conditions thermally uncomfortable. This can be due to radiant temperature asymmetry, vertical air temperature differences, draught, warm or cold floors.

Natural ventilation makes individual feel more thermally comfortable.

Learning outcomes of Session 5

The outcomes from this session are related with the concept of adaptation and in what way a person is able to adapt to the local conditions.

Learners will show an understanding of global and local thermal discomfort and of the aspects that influence the achievement of thermal comfort even that the thermal conditions are adequate.

Learners will be able to understand and to communicate to others the way natural ventilation can be used to improve thermal comfort conditions and how, when not adequately used can cause local thermal discomfort.

Learners will be able to explain the effect of the thermal sensitivity, gender, age, weight, culture of individuals affect the perception of thermal comfort.

Bibliography of Session 5

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Brager, G. S., de Dear, R. J. (1998). Thermal adaptation in the built environment: a literature review, Energy and Buildings 27

Clements-Croome, D. (ed) (2006). Creating the Productive Workplace, E&FN Spon, Taylor & Francis Group, London/New York, Second edition.

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4.6 Session 6: Thermal Comfort Predictive Models

Learning objectives of Session 6

The learning objectives of Session 6 are as follows:

- To be able to identify, explain and interpret the standards, at international and national level, that specify the conditions needed to ensure the thermal comfort and the models that each one define.
- To be able to identify the different thermal comfort models and to understand and explain how and when each one should be applied.
- To explain the conditions needed to ensure the thermal comfort conditions.
- To be able to determine the predicted mean vote (PMV) and the predicted percentage of dissatisfied (PPD).
- To be able to identify the categories of thermal environment and to determine the optimum operative temperature and the permissible temperature range as a function of clothing and activity for each of the three categories of thermal environment.
- To understand how the ASHRAE 55 comfort zone is defined in terms of a range of operative temperatures that provides acceptable thermal environmental conditions or in terms of the combinations of air temperature and mean radiant temperature that people find thermally acceptable.
- To be able to use different thermal comfort simulation tools.

Content of Session 6

In this session, the different standards and methods to predict or determine the conditions necessary to achieve thermal comfort conditions are presented, steady state and adaptive models and models to assess the local thermal discomfort are presented, namely the following:

- Thermal comfort predictive models

- EN ISO 7730 - PMV/PPD model
- AHSRAE 55 model
- EN 15251 model
- Adaptive thermal comfort models

- Simulation tools

This session is structured based on the standards that define the settings necessary to achieve thermal comfort conditions. EN ISO 77, ASRAE 55 and EN 15251 standards, as well as national models, are presented.

The session is concluded with the presentation of several thermal comfort simulation tools.

The duration of this session is estimated in 1.5h.

Summary of Session 6

EN ISO 7730 presents methods for predicting the general thermal sensation and degree of discomfort of people exposed to moderate thermal environments, also specifies how to predict the percentage of dissatisfied owing to local discomfort parameters.

ASHRAE 55 specifies the combinations of indoor thermal environmental factors and personal factors that produce thermal environmental conditions acceptable to the majority of the occupants within the space. It is intended for use in design, commissioning, and testing of buildings and other occupied spaces and their HVAC systems, and for the evaluation of thermal environments. ASHRAE 55 presents the conditions necessary to achieve thermal comfort and presents methods for predicting the general thermal sensation and degree of discomfort of people exposed to moderate thermal environments. It also specifies how to predict the percentage of dissatisfied owing to local discomfort parameters. Additionally, an adaptive thermal comfort model is presented.

EN 15251 is applicable mainly in non-industrial buildings where the criteria for indoor environment are set by human occupancy and where the production or process does not have a major impact on indoor environment. The standard divides indoor climate for different categories and also presents an adaptive method for assessing the thermal comfort conditions of a naturally ventilated building.

Thermal comfort tools are presented and discussed.

Learning outcomes of Session 6

The outcomes from this session are related with the prediction or analytical determination of the thermal sensation for the body as a whole using: PMV (predicted mean vote); PPD (predicted percentage of dissatisfied); ASHRAE 55 comfort zone, adaptive models and local thermal comfort criteria.

Learners will be able to explain and interpret the standards, at international and national level, that specify the conditions needed to ensure the thermal comfort and the models that each one define.

Learners will be able to understand and to communicate to others the different thermal comfort models and to understand and explain how and when each one should be applied.

Learners will show an understanding of the categories of thermal environment and be able to explain the conditions needed to ensure the thermal comfort conditions.

Learners will have the opportunity to demonstrate through the use of simulation tools the way parameters affect thermal comfort using the different thermal comfort predictive models.

Bibliography of Session 6

ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy

ISO 7243, Hot environments - Estimation of the heat stress on working man, based on the WBGT index (wet bulb globe temperature)

ISO 7726, Ergonomics of the thermal environment - Instruments for measuring physical quantities

ISO 7730, Moderate thermal environments – Determination of the PMV and PPD indices and specification of the conditions for thermal comfort

ISO 7933, Ergonomics of the thermal environment - Analytical determination and interpretation of heat stress using calculation of the predicted heat strain

ISO 8996, Ergonomics of the thermal environment - Determination of metabolic rate

ISO 9920, Ergonomics of the thermal environment - Estimation of the thermal insulation and evaporative resistance of a clothing ensemble

ISO 10551, Ergonomics of the thermal environment - Assessment of the influence of the thermal environment using subjective judgement scales

ISO 11399, Ergonomics of the thermal environment - Principles and application of relevant International Standards

ISO TR 11079, Ergonomics of the thermal environment - Analytical determination and interpretation of cold stress using calculation of the required clothing insulation (IREQ) and the assessment of local cooling effects

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Cyprus

The following decree laws set the minimum envelope requirements, as well as, the equipment to be installed in buildings.

- KDP 432/2013 - On the Regulation of the Energy Performance of Buildings (Minimum Requirements on the Energy Performance of Buildings) Decree;

- KDP 386/2013 – On the Regulation of the Energy Performance of Buildings (Requirements on New Technical Building Systems installed in existing buildings or building units and technical systems that are replaced or upgraded) Decree.

KDP 366/2014 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB)Decree.Nevertheless, the above-mentioned decree laws set the minimum requirements regarding the energy performance in buildings and none is related to the indoor thermal comfort conditions.

Greece

Greek Law 3661/2008, issued on the 19th of May 2008

Greek Regulation for the Energy Efficiency of Buildings, issued on the 9th of April 2010

Italy

ASHRAE Standard 55:2013, Thermal Environmental Conditions for Human Occupancy

EN 15251, Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

UNI EN ISO 7730, Moderate thermal environments – Determination of the PMV and PPD indices and specification of the conditions for thermal comfort

http://www.lumasenseinc.com/EN/products/thermal-comfort/pmv-calculation/

http://www.ddcode.com/mobile/th/thermal-comfort-pmv-calculator.html

Portugal

Decree-Law 118/2003, related Ordinances and Mandamus – Portuguese Energy Certification System; Regulation on the Energy Performance of Residential Buildings; Regulation on the Energy Performance of Office Buildings (sets the minimum quality of the envelope and indoor reference ambient temperatures to ensure the conditions for thermal comfort)

Matias, L., 2010. Desenvolvimento de um modelo adaptativo para a definição das condições de conforto térmico em Portugal. Coleção Teses e Programas de Investigação LNEC, TPI 65. LNEC, Lisboa

4.7 Session 7: Thermal Comfort Assessment

Learning objectives of Session 7

The learning objectives of Session 7 are as follows:

- To be able to identify the thermal comfort assessment procedures.
- To understand and explain how thermal comfort conditions can be monitored and evaluated.
- To identify what information and data must be provided prior to the monitoring and evaluation of the thermal comfort conditions of a space and the conditions that must be met to perform the survey.
- To explain the thermal comfort monitoring and measurements procedures.
- To explain the approaches that can be taken to evaluate thermal comfort.
- To be able to identify the measuring conditions, measurement positions and requisites of the sensors used in the assessment of the thermal comfort conditions, according to EN ISO 7730, ASHRAE 55 and EN 15251 and EN ISO 7726 standards.
- To be able to understand the methods for long-term evaluation of the general thermal comfort conditions, according to EN ISO 7730, ASHRAE 55 and EN 15251 standards.

Content of Session 7

In session 7, with 2.5h of duration, an overview of the thermal comfort assessment procedures is presented, as well as several monitoring and evaluation methods are presented:

- Thermal comfort assessment procedures overview
- Monitoring and evaluation
    - Empirical approach (surveys)
    - Analytical approach
    - Thermal comfort measurements. Sensors and equipment
    - Practical session with equipment

Summary of Session 7

Thermal comfort assessment procedures

Thermal comfort monitoring and measurements procedures

Measuring conditions, measurement positions and requisites of the sensors used in the assessment of the thermal comfort conditions

Methods for long-term evaluation of the general thermal comfort conditions

Learning outcomes of Session 7

The outcomes from this session are related with the minimum characteristics of instruments for measuring physical quantities characterizing an environment as well as the methods for measuring the physical quantities of this environment.

Learners will show an understanding of the documentation to be gathered during the preparation of a thermal comfort survey.

Learners will be able to explain the thermal comfort monitoring and measurements procedures, identify the measuring conditions, measurement positions and requisites of the sensors used in the assessment of the thermal comfort conditions.

Learners will be able to understand and to communicate to others the results of a thermal comfort survey.

Learners will be able to prepare and perform a survey for assessing the thermal comfort conditions of a room.

Bibliography of Session 7

ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy

ISO 7243, Hot environments - Estimation of the heat stress on working man, based on the WBGT index (wet bulb globe temperature)

ISO 7726, Ergonomics of the thermal environment - Instruments for measuring physical quantities

ISO 7730, Moderate thermal environments – Determination of the PMV and PPD indices and specification of the conditions for thermal comfort

ISO 7933, Ergonomics of the thermal environment - Analytical determination and interpretation of heat stress using calculation of the predicted heat strain

ISO 8996, Ergonomics of the thermal environment - Determination of metabolic rate

ISO 9888, Evaluation of thermal strain by physiological measurements

ISO 9920, Ergonomics of the thermal environment - Estimation of the thermal insulation and evaporative resistance of a clothing ensemble

ISO 10551, Ergonomics of the thermal environment - Assessment of the influence of the thermal environment using subjective judgement scales

ISO 11399, Ergonomics of the thermal environment - Principles and application of relevant International Standards

ISO TR 11079, Ergonomics of the thermal environment - Analytical determination and interpretation of cold stress using calculation of the required clothing insulation (IREQ) and the assessment of local cooling effects

EN ISO 12894, Ergonomics of the thermal environment – Medical supervision of individuals exposed to extreme hot or cold environments

ISO 13732-3, Ergonomics of the thermal environment – Touching of cold surfaces Part 3. Ergonomics data and guidance for application

ISO 15265, Ergonomics of the thermal environment – Risk assessment strategy for the prevention of stress and discomfort in thermal working conditions

ISO 15743, Ergonomics of the thermal environment - cold workplaces - risk assessment and management

EN 511, Specification for protective gloves against cold

EN 563, Safety of machinery – Temperatures of touchable surfaces – Ergonomics data to establish temperature limit values for hot surfaces

EN 14058, Protective clothing garments for protection against cool environments

EN 15251, Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

4.8 Session 8: Examples

Learning objectives of Session 8

The learning objectives of Session 8 are as follows:

- To be able to identify and explain good practice examples of buildings with adequate thermal comfort conditions
- To be able to identify the aspects that contribute to the thermal comfort conditions.

Content of Session 8

Session 8 presents a set of good practice examples, at European and national levels, of buildings with features and characteristics that improve thermal comfort conditions of the occupants. This session has an estimated duration of 0.5h.

Summary of Session 8

Best practice examples of buildings with adequate thermal comfort conditions.

Local practice examples of buildings with adequate thermal comfort conditions.

Learning outcomes of Session 8

The outcomes from this session are related with the identification of how it is possible to improve building characteristics to achieve thermal comfort conditions.

Learners will be able to understand and to communicate to others the characteristics of buildings that contribute to the achievement of adequate thermal comfort conditions.

Bibliography of Session 8

Annex 56 Shining Examples, available at: http://www.iea-annex56.org/index.aspx?MenuID=4

5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risk.

Risk - description	Risk Level	Risk management action
Lack of delivery of training materials by partners and complexity of developing four courses (i.e. one for each country).	High	UMinho to combine material supplied in each country with own material to create four versions of the course, one for each target country. Hold sessions on training courses at partners' meetings to resolve any issues; hold special tcfs for WP3 as required. Coordinator action as required.
Poor delivery of classroom training by target country partners and trainers	Medium	UMinho can coach the partners and the trainers through Q&A sessions by video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low - Medium	UMinho will monitor rates and amend course content to support areas where particular groups of questions are not well prepared.
Excessive differences in local issues	Low	UMinho will review local material and will advise on changes as required.

6 COMMENTS FROM EXTERNAL REVIEWER

In general, the PPT presentations for Module 4 are well structured and appropriately organized. They constitute valuable pieces of work.

Module 4 (Thermal Comfort) consists of 8 sessions and it covers all aspects of thermal comfort in a very comprehensive and illustrative way. The quantity of the stuff is adequate for the time allocated and the quality of the content is high. The presentation also includes a long list of bibliography. In addition to the theoretical issues and principles, this presentation includes data and information which concern the local context and the local regulations and standards, such as for example Session 3.

It is recommended that for at least this part of the presentation (Session 3), the sources of information are clearly mentioned either as footnotes or as references.

Note: The reviewer's comments related with the sources of information of Session 3 were taken into account and the missing references were included in the final version of the Module presentations.

APPENDIX E - DESCRIPTION OF MODULE 5: LOCAL ARCHITECTURAL REGULATIONS & CERTIFICATION FRAMEWORK

2 WP3 – TASK 2 - TRAINING MODULE 5 – DESCRIPTION

2.1 Outline of module 5

Module 5 aims to present to architects, engineers and municipality employees the SouthZEB approach for the verification and certification of nZEB in the target countries.

The module then goes on to discuss the special provision that SouthZEB has for building traditions and local architectural regulations as well as the user acceptance of technical solutions to nZEB. The module has been based on different training material for each target country, following the common framework and directions.

This training module has been coordinated, designed and planned by BRE, but partners from each country (Cyprus, Greece, Italy and Portugal) have develop the specific training material related to their own country. As a result the approach changes between countries in order to allow for local regulations and traditions to be fully explained.

The estimated training duration is 30 hours. It is addressing the needs of engineers, architects and municipality employees.

2.2 Purpose of the training

The purpose of the training is to inform professionals and other stakeholders on the need for near zero energy buildings. It addresses the SouthZEB certification framework and how the development of standards and certification of professionals is important with regards to new construction and also the retrofitting of existing buildings.

The training addresses how nZEB implementation could overcome obstacles posed by particularities such as apartment blocks, traditional settlements, islands and listed buildings.

A number of the issues that will be covered are as follows:

- The building typologies within each of the four target countries
- The current condition of the building stock and the potential for nZEB retrofit, with challenges and technical barriers highlighted; examples of solutions are given
- The building regulations in each country related to new construction, a complete overview will be given, with a focus on energy performance standards; the training will cover issues such as the use of national calculation methodologies and product certification
- The future direction of energy performance regulations in the country, how these will be achieved and how they relate to the EPBD
- The local architecture, with planning issues in cities and rural areas and how this affects the delivery of nZEB in that country
- The challenges and issues faced in achieving nZEB – supply chain, remote, rural & island locations, finance, skills (for design and construction) and legal issues.

2.3 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience, such as a course, webinar, self-study or group activity. Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experience(s).

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials. Learning objectives:

- Provide clarity about the purpose of the course.
- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals.
- Establish accountability between the learner and the instructor.
- Help trainers articulate exactly what they want participants to do by the end of the training.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound. .

The learning objectives of Module 5 are as follows:

- Objective5.1: Specific - to understand the SouthZEB certification framework and how this relates to the delivery of near zero energy buildings in each of the target countries.
    - Measurable – learners are able to describe the SouthZEB framework, showing understanding of the principles and the relationship to nZEN development in their own country and around Europe.
    - Action – learners will join the SouthZEB certification scheme on completion of training.
    - Reasonable – powerpoint slides are supported by scheme guidance documents available via the website, the learning required is commensurate with the objective.
    - Time-bound – learning will be completed after the training and completion of course reading.
- Objective 5.2: To understand the building regulations and how these relate to the design, construction and operation of nZEB in each country.
    - Measurable – learners are able to describe their own building regulations that are relevant in this area and the country plan towards implementation of nZEB.
    - Action – learners will be able to address the implementation of nZEB development within their own work, allowing planning for future developments at this level.
    - Reasonable – powerpoint slides are supported by learning documents available via the website, the learning required is commensurate with the objective.
    - Time-bound – learning will be completed after the training and completion of course reading.
- Objective 5.3: To understand and be able to offer solutions to the technical, practical and logistical challenges faced in each country in achieving nZEB.

- Measurable – learners are able to explain the challenges faced in their country, the impact of EU directives and how solutions could emerge within their market.
- Action – learners will be able to explain to clients, colleagues and other stakeholders the issues involved in nZEB including positive and negative aspects.
- Reasonable – powerpoint slides are supported by learning documents available via the website, the learning required is commensurate with the objective.
- Time-bound – learning will be completed after the training and completion of course reading.

- Objective 5.4: To be able to communicate the benefits of nZEB for each country.
  - Measurable – learners are able to explain the benefits of nZEB within their own country.
  - Action – learners will be able to explain to clients, colleagues and other stakeholders the issues involved in nZEB including positive and negative aspects.
  - Reasonable – powerpoint slides are supported by learning documents available via the website, the learning required is commensurate with the objective.
  - Time-bound – learning will be completed after the training and completion of course reading.

2.4 Learning audience – trainers and trainees – qualifications and experience

The trainers and trainees are those building professionals involved in the design and construction of buildings, as well as those involved in the building regulation system. Professions include architects, architectural technologists, engineers (mechanical and structural), building supervisors, site managers, clerk-of-works and building control professionals. Government and local authority officials involved in the regulation of near zero energy buildings are also included.

The trainers should be members of a relevant construction profession and have at least 2,5 years' experience in practice of the design and construction of near zero energy buildings. Experience of supervision of staff and previous experience in delivering training are also useful.

The trainees include the building professionals described above, but with any number of years' experience from graduation through to senior company Directors.

3 STRUCTURE OF MODULE 5

The structure of the 30 hour training course is as follows:

- Preparation – involving an on-line introduction and background reading, the approximate duration is:2 hours involved in background preparation on certification and verification; and 3 hours on local architecture and regulations. The total approximate duration is therefore 5 hours
- Class based training – involving delivery by a trainer of the main components of the training. The delivery is given by the approved trainer to between 10 and 20 trainees at each session. The approximate duration of the classroom training is 16 hours; this is split as 4 hours (0.5 day) on the certification framework; 8 hours on the local architecture and regulations (1 day) and 4 hours study tour or local nZEB buildings.
- Post classroom based training, self-learning and exam preparation. The approximate duration of this part of the training is 6 hours (2 hours on certification and verification, and 4 hours on local architecture and regulation). Attendees will also need to dedicate approximately 2 hours to prepare for assessment. The duration of the post classroom training, self-learning and exam preparation is therefore approximately 8 hours in total.
- Competence assessment – this is delivered through a one hour written exam and involves a multiple-choice exam. The assessment takes one hour to complete. The examination is split as one 30% on certification and verification, and 70% on local architecture and regulations.

3.1 Course reading material

Pre-classroom

A number of papers are provided on certification and verification in the built environment, especially concerning the design and construction of nZEB (BRE).

UN Framework on Climate Change: http://unfccc.int/essential_background/convention/items/2627.php

Construction products regulations and guidance: http://ec.europa.eu/growth/sectors/construction/product-regulation/index_en.htm

CE Marking: http://ec.europa.eu/growth/single-market/ce-marking/index_en.htm

European Technical Approval: http://www.eota.eu/en-GB/content/home/2/185/

Energy Performance of Buildings Regulations: http://www.epbd-ca.eu/

https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

http://www.eceee.org/policy-areas/buildings/EPBD_Recast

Thermal insulation:
http://ec.europa.eu/environment/gpp/pdf/thermal_insulation_GPP_%20background_report.pdf

http://www.ea-etics.eu/media;files/pdf/7/27.pdf

Energy efficient services: http://www.roadmap2050.eu/attachments/files/EnergySavings2020-FullReport.pdf

Post classroom

The specifics of the SouthZEB certification scheme (BRE) and relationship to building verification. Further reading / DVD of local architectural regulations in the country has been made available.

In each country reading material is available on local architecture, planning and building regulations (other partners) as set out in table 3.1.

Cyprus Circular 3/2008 (Ministry of Interior) – Installation of PV systems for which a planning permit is not required Mandate 2/2006 (Ministry of Interior) – Spatial distribution and installation of developments related to the energy production from Renewable Energy Sources 101(I)/2006 – On the regulation of Streets and Buildings Law Κ.Δ.Π. 429/2006 - On the Streets and Buildings (Energy Performance of Buildings) Regulations of 2006 Κ.Δ.Π. 61/2014 - On the Streets and Buildings (Energy Performance of Buildings) (Amendment) Regulations of 2014 Mandate 1/2014 – Use of Renewable Energy Sources related to building developments 240(I)/2002 – on the listed buildings law Manual for listed buildings (Ministry of Interior) 2000, ISBN 978-9963-38-587-4 Preserving the Architectural Heritage of Cyprus (Ministry of Interior), ISBN 978-9963-33-0362-2	Greece ➢ Guidelines to be followed during the construction / inspection of new build buildings and fully renovated buildings. The guidelines were issued by the Technical Chamber of Greece: http://portal.tee.gr/portal/page/portal/teetkm/DRASTHRIOTHTES/SEMINARIA/ ➢ Greek Law 4067/2012 Building legislation : http://www.ypeka.gr/LinkClick.aspx?fileticket=5nRUKLGIL8E%3D&tabid=506&language=el-GR ➢ General definition of nZEB concept, as per the recast EPBD Directive.Greek Law 4122/2013 : https://www.buildingcert.gr/N4122_2013.pdf ➢ The Centre for Renewable Energy Sources and Saving (CRES) has published relevant documents: http://www.cres.gr/services/istos.chtm?prnbr=25338&locale=el ➢ Relevant material by ministry of Environment and Energy: http://www.opengov.gr/minenv/wp-content/uploads/downloads/2012/04/energeiakos-sxediasmos.pdf ➢ Analytical parameters for the calculation of energy performance of buildings and issue of certificate of energy efficiency by ministry of Environment and Energy (TOTEE): http://portal.tee.gr/portal/page/portal/tptee/totee/TOTEE-20701-1-Final-%D4%C5%C5-2nd.pdf
Italy • ISTAT, Report 2004 • Elaboration and estimation from CRESME on data from ISTAT Censimento 2001 and Families survey 2012 www.cresme.it • www.enea.it • www.acs.enea.it/provvedimenti/ • ENERDATA – Italy energy report, August 2014 update • Corrado V., Ballarini I., Corgnati S.P., *Building Typology Brochure – Italy* – EPISCOPE Project (Luglio 2014) • "La sostenibilità energetica ed ambientale del Palazzo Italia di EXPO 2015: analisi di un edificio nZEB" presentation by prof. Ing. Livio de Santoli, http://www.kyotoclub.org/docs/Milano_080514_DeSantoli.pdf	**Portugal** Survey on Portugal energy consumption in the domestic sector (2010): https://www.ine.pt/ngt_server/attachfileu.jsp?look_parentBoui=127226940&att_display=n&att_download=y Projections of energy services demand for residential buildings: Insights from a bottom-up methodology: http://www.sciencedirect.com/science/article/pii/S0360544212007207 Thermal comfort criteria and building design: Field work in Portugal: http://www.sciencedirect.com/science/article/pii/S0960148109001074

• Rapporto Legambiente 2015 «Innovazione e semplificazione in edilizia: verso il regolamento edilizio unico» www.legambiente.it • D. Lgs. 63 - 4 Giugno, 2013 • D. Lgs 192/05 e D. Lgs 311/06 • D.P.R. 59/2009 • DM Linee Guida CE 26/06/2009 • D.L. 63/13 • Legge 90/13 • Legge 164/2014 • GSE – Rapporto statistico "Energia da Fonti Rinnovabili in Italia – 2013" • http://www.res-legal.eu/search-by-country/italy/tools-list/c/italy/s/res-e/t/promotion/sum/152/lpid/151 Affermative Integrated Energy Design Action «AIDA» – Guida dei migliori casi studio: Storie di successo, 2013 www.aidaproject.eu	Revisiting cooling energy requirements of residential buildings in Portugal in light of climate change: http://www.sciencedirect.com/science/article/pii/S0378778814001960 Ground source heat pump carbon emissions and primary energy reduction potential for heating in buildings in Europe—results of a case study in Portugal: http://www.sciencedirect.com/science/article/pii/S1364032115001227 Characterization of thermal performance and nominal heating gap of the residential building stock using the EPBD-derived databases: The case of Portugal mainland: http://www.sciencedirect.com/science/article/pii/S0378778813007615 The Use of Attached-sunspaces in Retrofitting Design: The Case of Residential Buildings in Portugal: http://www.sciencedirect.com/science/article/pii/S187661021400424X Energy and economic analysis of an integrated solar absorption cooling and heating system in different building types and climates: http://www.sciencedirect.com/science/article/pii/S0306261908002249 Portuguese vernacular architecture: the contribution of vernacular materials and design approaches for sustainable construction: http://www.tandfonline.com/doi/pdf/10.1080/00038628.2014.974019 Energy and economic analysis of an integrated solar absorption cooling and heating system in different building types and climates: http://www.sciencedirect.com/science/article/pii/S0306261908002249 The potential of vernacular materials to the sustainable building design: http://repositorium.sdum.uminho.pt/handle/1822/26013 The nZEBs in the near Future - Overview of definitions and guidelines towards existing plans for increasing nZEB: http://hdl.handle.net/10400.9/2283 Defects and moisture problems in buildings from historical city centres: a case study in Portugal: http://www.sciencedirect.com/science/article/pii/S0360132305000156 The Daily and Hourly Energy Consumption and Load Forecasting Using Artificial Neural Network Method: A Case Study Using a Set of 93 Households in Portugal: http://www.sciencedirect.com/science/article/pii/S1876610214034146 Solar XXI: A Portuguese Office Building towards Net Zero-Energy

	Building: http://hdl.handle.net/10400.9/1542 Sustainable architecture and urban design in Portugal: An overview: http://www.sciencedirect.com/science/article/pii/S0960148109000603

Table 3.1: Relevant training documents by country

4 CONTENT OF MODULE 5

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content has been split into two days. Each session is introduced by the trainer and the connection with the learning objectives and outcomes explained. The sessions vary in timing and content. The course material is delivered through powerpoint slides, which are made available to the trainees.

On Day 1 the course will involve one half day on certification and verification; new build / retrofit and housing and commercial options will be explored as to how they can demonstrate the realisation of nZEB.

On Day 2 the training will be classroom based and will focus upon the local architecture and regulations. The sessions are described in this section, including relevance to the objectives and the learning outcomes.

4.1 Session: NZEB current position

Learning objective

To understand the building regulations and how these relate to the design, construction and operation of nZEB in each country.

Content

The first session of the training module will address the current position on near zero energy buildings, in particular the following:

- European Union
- Target country (Cyprus, Greece, Italy and Portugal).
- Global, EU and national drivers
- Energy Performance of Buildings Directive.

The research explains The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty negotiated at the United Nations Conference on Environment and Development (UNCED), informally known as the Earth Summit, held in Rio de Janeiro from 3 to 14 June 1992. The objective of the treaty is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".

The increased use of energy from renewable sources and measures taken to reduce energy consumption in the Union would allow compliance with Kyoto protocol to the United Nations Framework Convention on Climate Change (UNFCCC) in addition to honouring long term commitments including:

- Maintaining the global temperature rise below 2oC;
- Reduce, by 2020, overall greenhouse gas emissions by at least 20% below 1990 levels; and by 30% in the event of an international agreement being reached.

The recast Directive 2010/31/EU on the Energy Performance of Buildings (EPBD) requires Member States to set minimum energy requirements which are at least ‘cost-optimal’1. The EPBD also requires Member States to review their energy standards in building regulations at intervals of not less than 5 years. More specifically, Article 9 of the Directive sets a requirement for ‘nearly zero energy’ new buildings from the end of 2018 (public sector) and 2020 (all new-build).

Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing directives 2001/77/EC and 2003/30/EC. This Directive sets binding targets for the Member States so that the EU as a whole will reach a 20% share of energy from renewable sources in gross final energy consumption by 2020 and a 10% share of renewable energy specifically in the transport sector.

The high level of energy consumption and GHG emissions in buildings in Europe makes this is an obvious sector to target in order to determine the potential and improve energy performance. While there has already been significant effort to improve energy performance in buildings, considerable potential still remains, as was noted by the European Commission's Communication on the proposal for the recast of the EPBD.

National legislation is set out in table 4.1.

Cyprus	**Greece**
N142(I)/2006 – On the Regulation of the Energy Performance of Buildings Law 2006 N30(I)/2009 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2009 N210(I)/2012 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2012 ΚΔΠ 164/2009 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) Regultions 2009 ΚΔΠ 39/2014 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) (Amendment) Regultions 2014 ΚΔΠ 412/2009 - On the Regulation of the Energy Performance of Buildings (Energy Performance Certificates of Buildings) Decree 2009 ΚΔΠ 432/2013 - On the Regulation of the Energy Performance of Buildings (Minimum Requirements on the Energy Performance of Buildings) Decree 2013 ΚΔΠ 432/2013 - On the Regulation of the Energy Performance of Buildings (Recommendations for the Improvement of the Energy Performance of Buildings and Energy Performance Certificate of Buildings) Decree 2013 ΚΔΠ 33/2015 - On the Regulation of the Energy Performance of Buildings (Methodology on the Energy Assessment of Buildings) Decree 2015 ΚΔΠ 164/2009 – The Streets and Buildings (Energy Performance of Buildings) Regulations 2009 ΚΔΠ 61/2014 – The Streets and Buildings (Energy Performance of Buildings) (Amendment) Regulations 2014 ΚΔΠ 343/2013 – On the Regulation of the Energy Performance of Buildings (Methodology for the calculation of the Cost Optimal	Greek Law 3851/2010 "Accelerating the Development of Renewable Energy Sources (RES) to Deal with Climate Change and Other Regulations in Topics under Authority of the Greek Ministry of Environment, Energy, and Climate Change" Greek Law 3661/2008 "Measures to reduce energy consumption in buildings and other provisions" Regulation for Energy Efficiency of Buildings (KENAK) issued in 2010 (Official Gazette Bulletin B' 407/09-04-2010), based on the Greek Law 3661/2008 Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B' 1387-2010 and 1413-2012 Greek Law 4122/2013 "Energy Performance of Buildings – Transposition of Directive 2010/31/EU"

minimum Requirements on the Energy Performance of Buildings) Decree 2013 ΚΔΠ 386/2013 – On the Regulation of the Energy Performance of Buildings (Requirements on New Technical Building Systems installed in existing buildings or building units and technical systems that are replaced or upgraded) Decree 2013 ΚΔΠ 366/2013 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB) Decree 2014 ΚΔΠ 163/2009 - On the Regulation of the Energy Performance of Buildings (Cooling Systems Inspection) Regulations 2009 ΚΔΠ 413/2009 - On the Regulation of the Energy Performance of Buildings (Cooling Systems Inspection) Decree ΚΔΠ 244/2015 - On the Regulation of the Energy Performance of Buildings (regulation and control of cooling systems of nominal power output greater than 20 kW) Decree ΚΔΠ 119/2011 - On the Regulation of the Energy Performance of Buildings (Inspection of boiler based Heating Systems) Regulations 2011 ΚΔΠ 148/2013 - On the Regulation of the Energy Performance of Buildings (Inspection procedure of heating systems equipped with a boiler of nominal power between 20 kW and 100 kW) Decree 2013 ΚΔΠ 149/2013 - On the Regulation of the Energy Performance of Buildings (Inspection procedure of heating systems equipped with a boiler of nominal power greater than 100 kW) Decree 2013 ΚΔΠ 244/2013 - On the Regulation of the Energy Performance of Buildings (regulation and control of heating systems equipped with a boiler of nominal output power greater than 20 kW) Decree 2013	
Italy ISTAT, Report 2004 EPBD recast 2010/31 / UE D. Lgs. 63 - 4 Giugno, 2013 D. Lgs 192/05 e D. Lgs 311/06 D.P.R. 59/2009 DM Linee Guida CE 26/06/2009 D.L. 63/13	**Portugal** Decree-Law 118/2013; Decree-Law 78/2006; Decree-Law 79/2006; Decree-Law 80/2006

Legge 90/13 Legge 164/2014	

Table 4.1: Relevant national regulations covered in session 1

Learning outcomes

The outcomes from Session 1 will be as follows:

- Knowledge of building regulations that are relevant in this area and the country plan towards implementation of nZEB;
- Learners that re able to address the implementation of nZEB development within their own work, and will allow planning for future developments at this level.
- A training session of powerpoint slides supported by learning documents available via the website, the learning required is commensurate with the objective.
- Learning will be completed after the training and completion of course reading, from classroom to completion average of four weeks.

4.2 Session: local architecture and development in the country

Learning objective

To understand the building regulations and how these relate to the design, construction and operation of nZEB in each country.

Contents

Building energy performance in target country are covered in this session. It includes new buildings and includes historic/listed buildings, development of building types through the 20th and 21st centuries, giving examples of typology and their energy performance.

The session commences by addressing learners understanding the development of building and architecture in the target country, including the current situation and future development needed for nZEB, including the benefits of nZEB to the target country.

The session addresses the building typology in the target country (see table 4.2), with the numbers of buildings and known data on performance provided.

Cyprus	**Greece**
There are slightly more than 500000 buildings currently in Cyprus Around 430000 units have been constructed for residential purposes Following the financial crisis, around 5000 permits are issued each year for residential buildings and less than 1000 for non-residential buildings	Typology of building stock: ▪ Class A (1919–1945) ▪ Class B1 (1946–1960) ▪ Class B2 (1961–1980) ▪ Class C (1981–1990)

Approximately 80% of the current building stock in Cyprus has been built prior 2006, thus prior the enforcement of any legislation and regulations related to the energy performance of buildings 9 out of 10 new buildings are intended for residential purposes 65% of buildings are situated in urban areas, while the rest 35% are situated in rural areas. Almost 85% of constructed residential buildings are single family houses, semidetached houses or single houses situated in large residential complexes. 15% of residential buildings are multifamily buildings with a substantial number of apartments <1950s: traditional with usually 2-3 rooms, made out of stone or clay/hay masonry walls with pitched clay-tile roof and only amenity a fireplace used for heating purposes and cooking. 1950s-1960s: the first neoclassic buildings appear in the city centres with one or two storeys. 1960s-1970s: the first multi-storey buildings are being constructed. 1970s-2000s: Multi-storey buildings for commercial as well as residential purposes in city centres. 2000s-today: Modern architecture commercial buildings and organized residential complexes intended for holiday villas.	▪ Class D (1991–2010) ▪ Class E (2010–today) For each category the main characteristics of the construction are provided based on the current legislation, as well as the innovations of each period (e.g. the use of the elevators during the period covered in Class A buildings). The architectural regulation and its development through the years focussing on the construction materials of the buildings is also presented, reaching the current status and the legislation currently in force regarding the energy performance of the buildings.
Italy ENERDATA – Italy energy report, August 2014 update Elaboration and estimation from CRESME on data from ISTAT Censimento 2001 and Families survey 2012 www.cresme.it Distribution of the primary energy used for sector, in Mtep (Source: ENEA, 2009 www.enea.it) ENEA, Energy Report 2008Corrado V., Ballarini I., Corgnati S.P., Building Typology Brochure – Italy – EPISCOPE Project (Luglio 2014) “La sostenibilità energetica ed ambientale del Palazzo Italia di EXPO 2015: analisi di un edificio nZEB” presentation by prof. Ing. Livio de Santoli,	**Portugal** 3.5 million buildings totally or partially allocated to housing 87% single-dwelling and multi-family 1.034 million residential buildings constructed in the last two decades Approx .180,000 non-residential buildings constructed over the same period About 300 - 400 thousand, non-residential buildings has been growing in the last decades 80% of the Portuguese buildings have reference heating needs >

http://www.kyotoclub.org/docs/Milano_080514_DeSantoli.pdf Giornata di Studio su Tecnologie, tecniche impiantistiche e mercato del fotovoltaico, BIPV, verso la Zero Energy House	100 kWh/m2 year.

Table 4.2: Relevant building data (summarised) covered in session 2

The session teaches about the context of the target country the building types have changed, including the following:

- Replacement rates
- Industry issues
- Ownership issues.

For each country the building typology and performance is addressed by era (e.g. pre-1919, post 1945, etc); the session addresses the following aspects:

- Types
- Energy performance
- Good practice examples of upgrading.

The training session uses examples from above building types, it sets out development in energy standards, for the following:

Improved window/door/glazing insulation, different types of material (frame / glass, etc).

- Development and introduction of insulation materials in the country
- Improvements in energy services, heating, cooling, lighting and others
- Improvements in roof, floor and wall standards
- Introduction of renewable energy solutions.

Trainers explain why energy performance changes and how well this has improved over the past century. Examples are provided for different types of buildings of various eras, the practicality of improving existing buildings to reach current standards is discussed.

Learning outcomes

Learners will be able to elaborate the following:

- Describe the benefits to the target country of nZEBs
- Current situation within the country with regards to:
    - Reducing resource use – energy
    - Reduced running costs
    - Improved built environment.

4.3 Session: planning for nZEB

Learning objectives

To understand and be able to offer solutions to the technical, practical and logistical challenges faced in each country in achieving nZEB.

To be able to communicate the benefits of nZEB for each country.

Content

In this session the learners will be taught to understand the planning process as related to nZEB in the target country. Set out are the planning legislation and regulations that is relevant to new buildings and to the retrofitting of existing buildings. The session includes how the planning system is administered in the target country; e.g. through local authorities and/or other bodies. The extent to which policy has been devolved to cities/municipalities and how this impacts on nZEB for new development and retrofitting is covered. Table 4.3 covers the main planning issues that affected nZEB in each country.

The target countries should ensure that good quality data are available, including:

- Climate data matching the minimum quality specified in EN standards, ideally on a grid of a few kilometres space and both based on recent measurements and on forecasts of future weather evolution, as e.g available in U.K. by CIBSE;
- Cost data for building components, explicitly and clearly correlated to their physical and performance features; analysis of potential technological and cost evolution of main components. At present those data in many cases are difficult to access for policymakers, designers, etc.

Cyprus	**Greece** The current legislation is presented emphasising the points where planning for the nZEB is mentioned and the motives that are provided for the construction of low-energy buildings. Obstacles for implementing nZEB, focusing on the legislation, the lack of technical knowledge and the availability of new technologies and cost/funding opportunities. In this section the restrictions set by the legislation in historic buildings and traditional settlements are presented, providing also specific examples. Examples are also provided for the obstacles mentioned for better understanding. Opportunities in the implementation of the nZEBs are described. The opportunities mainly address to the climate of the country, the sector of solar thermal systems, the availability of the renewable energy and the incentives that are to be provided as per the New Building Regulation.
Italy D.L. 63/2013 GSE – Rapporto statistico “Energia da Fonti Rinnovabili in Italia –	**Portugal** National Energy Efficiency Action Plans; National Renewable Energy Action Plans

2013" http://www.res-legal.eu/search-by-country/italy/tools-list/c/italy/s/res-e/t/promotion/sum/152/lpid/151	Decree-Law 118/2013 (includes Regulations on Residential Building Energy Performance and the Regulations on the Energy Performance of Buildings for Commerce and Services).

- Table 4.3: Relevant planning in target countries covered in session 3

The training session examines the planning related obstacles to nZEB development. It addresses the retrofit of historic buildings / cultural heritage and rules on changes to the external fabric and appearance. The session addresses other obstacles for older buildings, and considers the skills issues, design and workmanship, that may hold back the target of nZEB refurbishment in the country. The obstacles include the following in each country:

- Apartment block retrofits
- Availability of good systems
- Cost / affordability
- Durability and performance
- Skills issues – design and workmanship.

In new build situations the planning issues related to new build development are covered. New build residential apartment blocks and single family dwellings, and commercial and public buildings are covered. Some of the planning issues that arise include the following:

- Apartments – space for renewables
- Single family units – renewable allowance, feed in tariffs, etc.
- Obstacles to design and construction, delivery
- Private and public sector delivery issues.

Learning outcomes

The outcomes from this session are related to the planning requirements for nZEBs. Learners will be able to understand and to communicate to others the main panning issues in their country related to nZEBs. The will in particular show an understanding of retrofitting of existing buildings, including how planning affects improvements to fabric, services and renewables. For new build the planning requirements and potential obstacles will be understood.

4.4 Session: building regulations

Learning objectives

To understand and be able to offer solutions to the technical, practical and logistical challenges faced in each country in achieving nZEB.

To be able to communicate the benefits of nZEB for each country.

Content

This overview of the country situation and specifics of energy building regulations (and indeed other regulations).

The session will commence by explaining the history of building regulations in the target country, issues such as when did the modern building regulation (may be called codes or standards as well) in the country and what developments have taken place. In the UK, the Building (Scotland) Act 1959 was the first legislation that enabled regulations and associated standards (there was a form of system before, but not part of legislation), the legislation was in place until 2003 when a new Act was passed, this fundamentally changed the system. Note that in the UK building regulation is a devolved matter for the Scottish Government, in fact the UK now has four sets of building regulations.

In Scotland the 1959 Act was supported by regulations to cover health & safety initially, over time energy efficiency was added, the accessibility and sustainability. Energy regulations came in early 70s at the time of the oil crisis.

Table 4.4 summarises the building regulation system in each of the target countries.

Cyprus	**Greece**
<u>General Legislation and Regulations on Buildings</u> 101(I)/2006 – On the regulation of Streets and Buildings Law of 2006 19(I)/2016 – On the regulation of Streets and Buildings (Amendment) Law of 2016 On the Streets and Buildings Regulations of 1954 to 2003 Κ.Δ.Π. 479/2011 - On the Streets and Buildings (Amendment) Regulations of 2011 Κ.Δ.Π. 144/2013 - On the Streets and Buildings (Amendment) Regulations of 2013 Κ.Δ.Π. 111/2006 - On the Streets and Buildings (Mechanical and Electrical Installations) Regulations of 2006 On the Town and Planning Laws of 1972 to 2016 <u>Energy Performance of Buildings Legislation and Regulations</u> N142(I)/2006 – On the Regulation of the Energy Performance of Buildings Law 2006 N30(I)/2009 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2009 N210(I)/2012 - On the Regulation of the Energy Performance of Buildings (Amendment) Law 2012 ΚΔΠ 164/2009 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) Regulations 2009 ΚΔΠ 39/2014 – On the Regulation of the Energy Performance of Buildings (Energy Certification of Buildings) (Amendment)	The historic development of the construction regulation is provided from 1828 till nowadays. Main information is presented for each legislation. The legislation currently in force is described and main issues are presented especially in the energy efficiency sector and the procedure followed for the construction of the building. The impact of the EPBD Directive in the Greek legislation is mentioned. The energy regulations since 1979 are also presented, as well as the main characteristics of them. For the current regulation (KENAK), the issues stated mainly refer to the EPCs, the methodology to be followed for their issue and the energy inspectors (categories, responsibilities). Obstacles in designing nZEBs with the current methodology are presented and modifications in current status are mentioned. Related legislation affecting the implementation of nZEBs is presented (New Building Regulation (Greek Law 4067/2012).

Regultions 2014 ΚΔΠ 412/2009 - On the Regulation of the Energy Performance of Buildings (Energy Performance Certificates of Buildings) Decree 2009 ΚΔΠ 432/2013 - On the Regulation of the Energy Performance of Buildings (Minimum Requirements on the Energy Performance of Buildings) Decree 2013 ΚΔΠ 432/2013 - On the Regulation of the Energy Performance of Buildings (Recommendations for the Improvement of the Energy Performance of Buildings and Energy Performance Certificate of Buildings) Decree 2013 ΚΔΠ 33/2015 - On the Regulation of the Energy Performance of Buildings (Methodology on the Energy Assessment of Buildings) Decree 2015 ΚΔΠ 164/2009 – The Streets and Buildings (Energy Performance of Buildings) Regulations 2009 ΚΔΠ 61/2014 – The Streets and Buildings (Energy Performance of Buildings) (Amendment) Regulations 2014 ΚΔΠ 343/2013 – On the Regulation of the Energy Performance of Buildings (Methodology for the calculation of the Cost Optimal minimum Requirements on the Energy Performance of Buildings) Decree 2013 ΚΔΠ 386/2013 – On the Regulation of the Energy Performance of Buildings (Requirements on New Technical Building Systems installed in existing buildings or building units and technical systems that are replaced or upgraded) Decree 2013 ΚΔΠ 366/2013 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB) Decree 2014 ΚΔΠ 163/2009 - On the Regulation of the Energy Performance of Buildings (Cooling Systems Inspection) Regulations 2009 ΚΔΠ 413/2009 - On the Regulation of the Energy Performance of Buildings (Cooling Systems Inspection) Decree ΚΔΠ 244/2015 - On the Regulation of the Energy Performance of Buildings (regulation and control of cooling systems of nominal power output greater than 20 kW) Decree ΚΔΠ 119/2011 - On the Regulation of the Energy Performance of Buildings (Inspection of boiler based Heating Systems) Regulations 2011 ΚΔΠ 148/2013 - On the Regulation of the Energy Performance of Buildings (Inspection procedure of heating systems equipped with a boiler of nominal power between 20 kW and 100 kW) Decree	

2013 ΚΔΠ 149/2013 - On the Regulation of the Energy Performance of Buildings (Inspection procedure of heating systems equipped with a boiler of nominal power greater than 100 kW) Decree 2013 ΚΔΠ 244/2013 - On the Regulation of the Energy Performance of Buildings (regulation and control of heating systems equipped with a boiler of nominal output power greater than 20 kW) Decree 2013	
Italy Legge 164/2014 Direttiva EPBD 2002/91/EU Direttiva EPBD recast 2010/31/EU D. Lgs 192/2005 e D.Lgs 311/2006 D.P.R. 59/2009 DM Linee Guida CE 26/06/2009 D.L. 63/2013 Legge 90/2013	**Portugal** Decree-Law 118/2013; Decree-Law 68 -A/2015; Decree-Law 194/2015

- Table 4.4: Relevant regulation in target countries covered in session 4

The session goes on to explain to learners what changes have been brought about in the target country on building regulations since the EPBD and other relevant EU directives were introduced. The future of building regulations should also be discussed.

The main part of the session will include the following, explaining in a non-technical way the energy regulations and associated guidance:

- The standards / performance needed to achieve nZEB in the country.
- How designs are assessed for nZEB by building regulation authorities
- How work in progress and completed buildings are assessed, e.g. visual checks, certification, post construction testing (airtightness, thermal imaging, etc).
- The roles and responsibilities of designers and builders, and the building regulation authrorities.
- The national calculation methodology, how is it used in building regulation in the target country, what are the models for housing and non-domestic buildings, in the UK approved software only can be used for compliance checking purposes
- What needs to develop in building regulation in order to assist developers with nZEB, etc

The session will then address what other legislation and regulations in the target country affect the realisation of nZEBs. For example, specific EPC regulations, on their own they do not require nZEB, but

the EPC rating has now to be used in property transactions at sale/rental and advertised. In some countries Climate Change legislation will soon require that existing non-domestic buildings have to have cost-effective improvement measures taken on sale or rental.

Learning outcomes

The outcomes of this session for learners will be an understanding of the building regulation system, the current energy regulations, what performance is expected for energy at present and in the future, how regulations will impact on the development of nZEBs; including both new builds and retrofit of existing buildings.

4.5 Session: Country specific issues

Learning objectives

To understand and be able to offer solutions to the technical, practical and logistical challenges faced in each country in achieving nZEB.

To be able to communicate the benefits of nZEB for each country.

Content

The content of this module aims to result in achieving nZEBs in each of the target countries in line with the EPBD requirements. Issues such as described in this section will be taught in this module.

Article 2 defines a nearly zero-energy building as "'nearly zero-energy building' means a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby". According to Annex I, article 1, "The energy performance of a building shall be determined on the basis of the calculated or actual annual energy that is consumed in order to meet the different needs associated with its typical use and shall reflect the heating energy needs and cooling energy needs (energy needed to avoid overheating) to maintain the envisaged temperature conditions of the building, and domestic hot water needs. Within these sentences, there are several terms that need further clarification, interpretation and development. This is one of the core tasks of this project, dedicated to support the Commission in ensuring a proper implementation of this regulation that fits to the overall energy and climate targets of the EU.

Member States also need to draw up national plans to increase the number of nearly zero-energy buildings. The national plans shall include inter alia the Member State's detailed application in practice of the definition of nearly zero-energy buildings, reflecting their national, regional or local conditions, the intermediate targets for improving the energy performance of buildings by 2015, and any policies and financial or other measures to promote nearly zero-energy buildings. The Commission will evaluate the national plans and shall by 31 December 2012 and every three years thereafter publish a report on the progress of Member States in increasing the number of nearly zero-energy buildings.

Use of the climate and natural resources in target country, the dependence or otherwise on fossil fuels and the potential to harvesting power from the sun or other natural resources will be addressed. These issues may include some highly localised examples, e.g. hydro power may be possible in more mountainous regions, but not so on lower lying topography. The potential in each country will be addressed.

The local tradition of building materials and their relative performance together with any risks that arise from their use will be addressed by the training modules. The potential in each country for greater recycling and

reuse of materials will be addressed through examples. The impact on embodied energy and carbon of materials use and resources will be addressed.

Table 4.5 summarises the country specific issues covered in each of the target countries.

Cyprus	Greece There is a great interest in reducing energy consumed for heating.(, resident's heating needs rate is about 70% of total energy consumption) Due to the Mediterranean climate, the energy needs are greater for summer cooling than winter heating. Greece has a very large number of applications of active solar systems. In recent years (2009- 2013), the P/V systems have spread rapidly in Greece, but now only 1,5% of this market is active. The second most important energy source in Greece is the wind power 2,4% of total electricity is produced from Biomass and Biofuels, currently derives from landfills and sewage treatment plants of urban waste water In Greece, hydropower covers approximately 8.3% of the energy needs in electricity. Nowadays there is little interest in geothermal energy and new ecological building materials In Greece, there are various softwares used by engineers who design nZEB
Italy Rapporto Legambiente 2015 «Innovazione e semplificazione in edilizia: verso il regolamento edilizio unico»	**Portugal** Most of the residential building stock before the first Portuguese thermal regulation the thermal insulation of the envelope are inadequate; 50% of dwellings are from before 1990, indicating the potential that these buildings have for energy efficiency renewal; Ceramic tiles roofs and concrete structure and hollow brick walls for main buildings; Solar heating for DHW widely applied after 2009 and Heating systems (gas boilers) after 2000; Portugal building Uvalue genrally higher than colder climate countries;

	The Portuguese mainland climate (latitude ranges from 37 to 42 North), according to Köppen-Geiger classification, is classified as Mediterranean, Csa in the south (hotsummer) and Csb in the north (warm summer); The most successful combinations for annual energy demand reduction have in common south orientation, fully integrated sunspace configuration, natural ventilation of the sunspace and inner shading devices with high reflectance.

Table 4.5: Relevant country specific issues covered in session 5

Learning outcomes

The issues and factors that will allow the target country to move towards a situation where nZEBs are being realised. Learners will have the opportunity to demonstrate through the assessment their understanding of the country specific issues that impact on energy performance.

4.6 Session: Examples of nZEB in the country and country tours

Learning objectives

To understand and be able to offer solutions to the technical, practical and logistical challenges faced in each country in achieving nZEB.

To be able to communicate the benefits of nZEB for each country.

Content

In this part of the training module for each country examples will be given of good practice with regards to nZEB design and construction within the target country. The materials include the following for each example:

- A description of the design of the building (domestic housing and non-domestic commercial and public buildings are given). The drivers for creating the nZEB building and the perceived benefits to the client and building users will be discussed.
- A discussion of the process and whether or not design was different and the engagement needed by the different actors – designers, contractors, etc, in comparison with more traditional forms of construction.
- A description of the building fabric, services, renewables and low carbon technology used will be given. This is described in the context of the building, but also the country situation.
- What nZEB performance was set, how much better than minimum national requirements, how was this driven within the project. Measures and models used to assess the nZEB status are described. The session also includes the certification and certificates that demonstrate how and what the building achieved, i.e. proof of its nZEB status. Any post construction assessment is also included within this session.
- The session will include showing layouts and design drawings, including details such as linear thermal bridges and fabric U-values. The specifications of the fabric and services will also be

addressed. Any design changes that have arisen within the project will also be described and how these impacted on the expected performance.

Table 4.6 summarises the country specific examples covered in each of the target countries.

Cyprus	**Greece** ENVELOPE -Interventions on the building envelope -Actual envelope construction (e.g. use of thermal insulation for walls/roof/floor, use of double glazing, and use of shading) SYSTEMS -Interventions on the systems for space heating and DHW RES -Incorporation of RES systems and techniques (PVs, solar collectors, etc)
Italy Affermative Integrated Energy Design Action «AIDA» – Guida dei migliori casi studio: Storie di successo, 2013 www.aidaproject.eu	**Portugal** SolarXXI building

Table 4.6: Relevant country specific examples covered in session 6

Learning outcomes

The delegates will have learnt what makes a nZEB in the country. Examples will be given of the design, construction and operation of housing and non-domestic buildings.

4.7 Session: EPDB

Learning objectives

- To understand the importance of the Energy Performance of Buildings Directive (EPBD) to the development of nZEB buildings in Europe.
- To learn about the areas covered by the EPBD and to understand how these are transposed into national legislation and requirements.

Content

The module covers a range of issues, as follows:

- The reasons as to why the EPBD has come into force, the bigger picture issues of climate change and resource efficiency.
- The history of the EPBD, including the original version, and the recast of the EPBD. As of 31 December 2020 new buildings in the EU will have to consume 'nearly zero' energy and the energy will be 'to a very large extent' from renewable sources. Public authorities that own or occupy a new building should set an example by building, buying or renting such 'nearly zero energy building' as of 31 December 2018
- Article 1: Promotes the improvement of the energy performance of buildings, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness.
- Article 2: there are 19 definitions given, example for building, means a roofed construction having walls, for which energy is used to condition the indoor climate.
- Article 3: adoption of a methodology for calculating the energy performance of buildings.
- Article 4: setting of minimum energy performance requirements.
- Article 5: Calculation of cost-optimal levels of minimum energy performance requirements.
- Article 6: For new buildings, Member States shall ensure that, before construction starts, the technical, environmental and economic feasibility of high-efficiency alternative systems.
- Article 7: For retrofit, requirements shall be applied to the renovated building or building unit as a whole, additionally or alternatively, requirements may be applied to the renovated building elements.
- Article 8: System requirements shall be set for new, replacement and upgrading of technical building systems and shall be applied in so far as they are technically, economically and functionally feasible
- Article 9: Member States shall ensure that: by 31 December 2020, all new buildings are nearly zero- energy buildings; and after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings.
- Article 10: Member States shall draw up, by 30 June 2011, a list of existing and, if appropriate, proposed measures and instruments including those of a financial nature, other than those required by this Directive, which promote the objectives of this Directive.
- Article 11, 12 and 13: The energy performance certificate, a requirement which may include additional information such as the annual energy consumption for non- residential buildings and the percentage of energy from renewable sources in the total energy consumption. Article 13 covers the display aspect of the EPC.
- Article 14: Member States shall lay down the necessary measures to establish a regular inspection of the accessible parts of systems used for heating buildings, such as the heat generator, control system and circulation pump(s), with boilers of an effective rated output for space heating purposes of more than 20 kW; include an assessment of the boiler efficiency and the boiler sizing compared with the heating requirements of the building.
- Article 15 and 16: necessary measures to establish a regular inspection of the accessible parts of air-conditioning systems of an effective rated output of more than 12 kW and reporting.
- Article 17 and 18: Member States shall ensure that the energy performance certification of buildings and the inspection of heating systems and air-conditioning systems are carried out in an

independent manner by qualified and/or accredited experts, whether operating in a self-employed capacity or employed by public bodies or private enterprises.

- Article 19: The Commission, assisted by the Committee established by Article 26, shall evaluate this Directive by 1 January 2017 at the latest, in the light of the experience gained and progress made during its application, and, if necessary, make proposals.
- Article 20: Member States shall take the necessary measures to inform the owners or tenants of buildings or building units of the different methods and practices that serve to enhance energy performance.
- Article 21: Member States shall ensure that guidance and training are made available for those responsible for implementing this Directive.

Learning outcomes

The learning outcomes are a detailed understanding of the EPBD and knowledge of its contents. Trainees will understand the importance of the Directive and why it has been brought into existence. The targets and the impact on design and construction will be understood.

4.8 Session: Certification Framework: Construction Products Regulations

Learning objectives

- To understand the Certification Framework of SouthZEB.
- To have sufficient knowledge to communicate the certification scheme and its value to prospective users of energy design and construction services.

Content

The framework applies to the following:

- New build domestic buildings of any type being built to a near zero energy building standard
- Existing domestic buildings of any type undergoing a near zero energy refurbishment
- New build non-domestic buildings of any type built to a near zero energy building standard
- Existing non-domestic buildings of any type undergoing a near zero energy refurbishment.

The certification framework is open to anyone who wishes to become a member of the SouthZEB scheme and who has appropriate qualifications and experience. Qualifications gained in other parts of Europe and elsewhere, may be relevant to membership. Members will include the following professionals:

- Architects and architectural technologists
- Building engineers and scientists
- Building services (electrical, mechanical)
- Civil and structural engineers
- Surveyors (building, quantity)

- Planners
- Local authority and housing authority asset managers
- Facility and property managers
- Construction finance and accountancy professionals.

The minimum requirements for memberships are as follows:

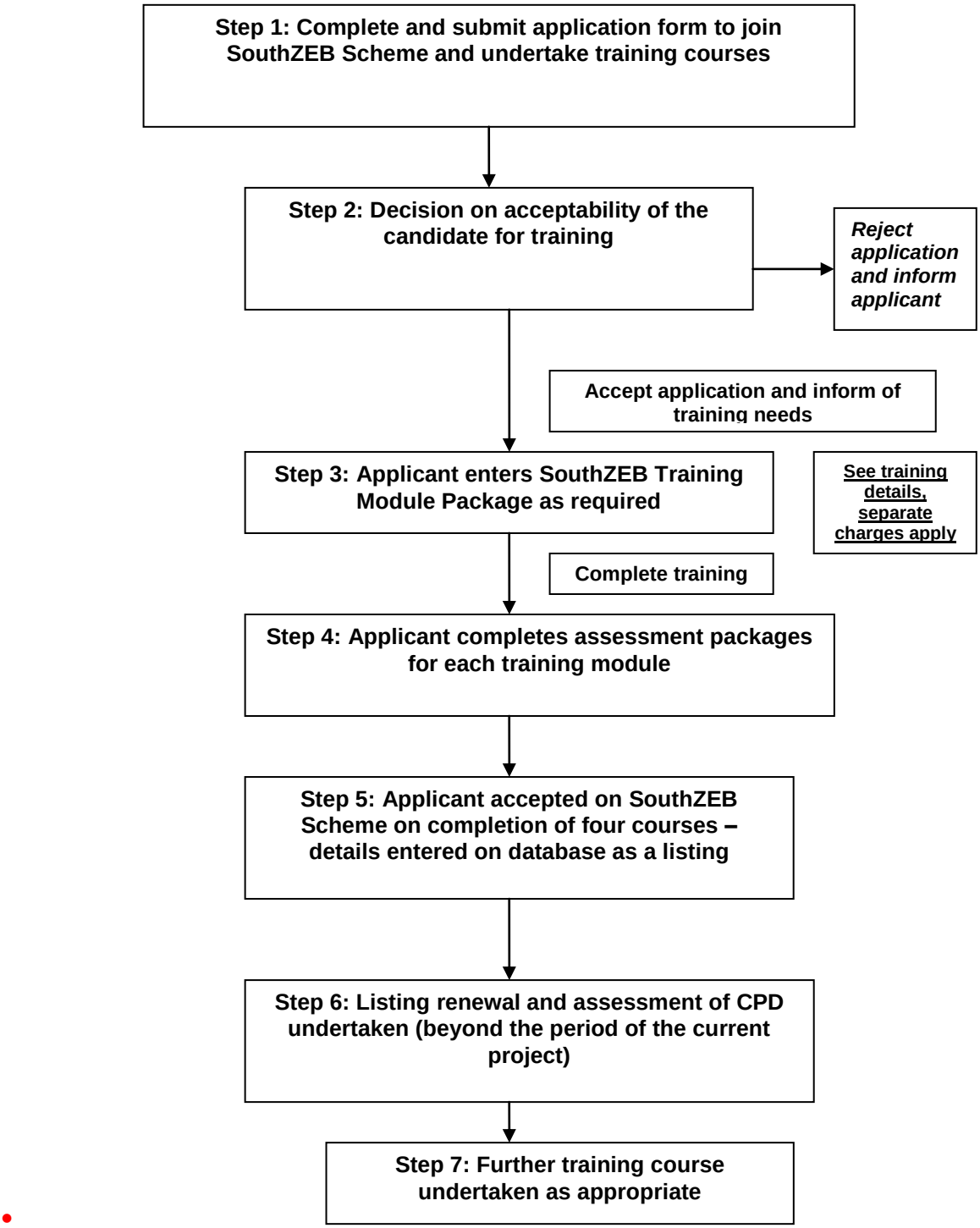
- Appropriate academic degree in order to adequately address aspects regarding the design and construction of buildings
- Relevant occupational license
- In case of trainers it is expected to have minimum 2,5 years of relevant experience, whereas in case of trainees no experience is required.

Assessment of an applicant's suitability to join the scheme based on satisfactory submission of information and matched against the requirements above. Initial assessment (on-line tests) will be undertaken through the portal, if data is not entered then the candidate cannot be accepted onto the training and certification scheme. Further additional information may be requested from applicants as appropriate.

SouthZEB Certificates are valid from the date of issue and are maintained and held in force subject to on-going compliance with the requirements for maintenance of certification, but remain the property of the partners. Details of the successful applicants are held on the SouthZEB Scheme Register.

The membership application process is set out in the figure 4.1.

The timeframe of the SouthZEB project covers the period from 2015 to 2020, including both trainers and trainees members. In the period after 2016 the SouthZEB initiative shall be the responsibility of the national partners in association with national stakeholders.



The key to the success and wide scale uptake of the SouthZEB project is the ability to deliver consistently high standards of training through the trainer network. Figure 4.2 sets out a simplified framework, where the training module is delivered by a SouthZEB trainer and multiple trainees are then trained. The intention is to increase the capacity of the construction sector in the four target countries to design, construct and operate near zero energy buildings.

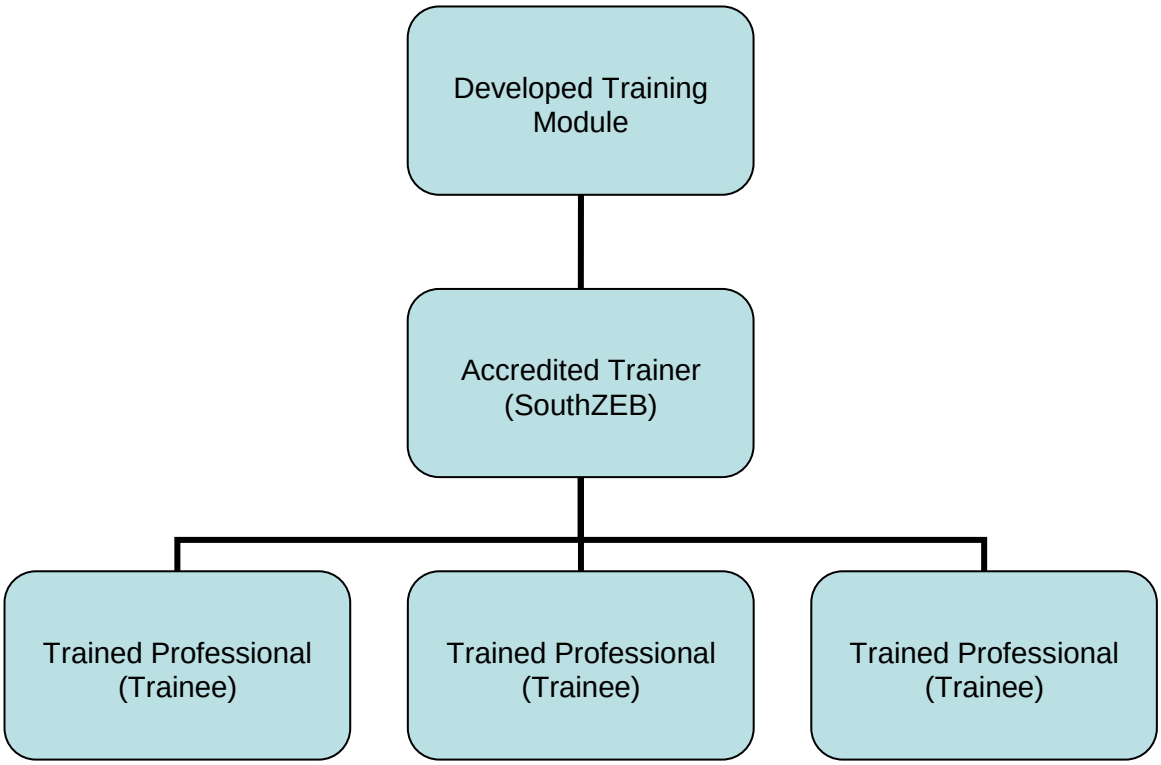


Figure 4.2: Increased capacity through 'Certified Trainers'

Certified SouthZEB trainers

In order to ensure a consistently high level of training throughout the SouthZEB project all certified trainers must meet minimum competence requirements.

The SouthZEB trainers will require the following level of competence:

- A degree level qualification in a relevant discipline and more specifically the participant should be eligible in building's design and construction, at the SouthZEB manager's discretion equivalent qualifications or experience may be considered (European Qualifications Framework EQF Level 4).
- At least two and a half years' experience in a construction environment, although national perspectives will also be applicable and as such the period of time should be used as guidance.
- Membership of a relevant professional body.

In the period of the SouthZEB project the assessment of a candidate's suitability will be via a self-check. Candidates will enter their data on the portal, as long as the data fields are appropriately completed then their candidature will be accepted.

Figure 4.3 provides an overview of the process of accrediting a SouthZEB trainer.

SouthZEB trainers can be trained and certified to deliver one or more of the SouthZEB training courses. It is not necessary to complete all ten courses, but a minimum of four courses has been determined as necessary in order to become a SouthZEB trainer. The trainer will complete the training course including the pre-course material, the classroom training and the post-class training.

SouthZEB trainers will also be required to complete the train the trainer course, which can be undertaken through the portal.

On completion of the assessment (examination) for each module and achieving a suitable pass mark the SouthZEB trainer will receive a SouthZEB trainer certificate. The trainer will then be available to deliver training.

A trainer will be a member of SouthZEB for a period of not less than the period of the funded SouthZEB project.

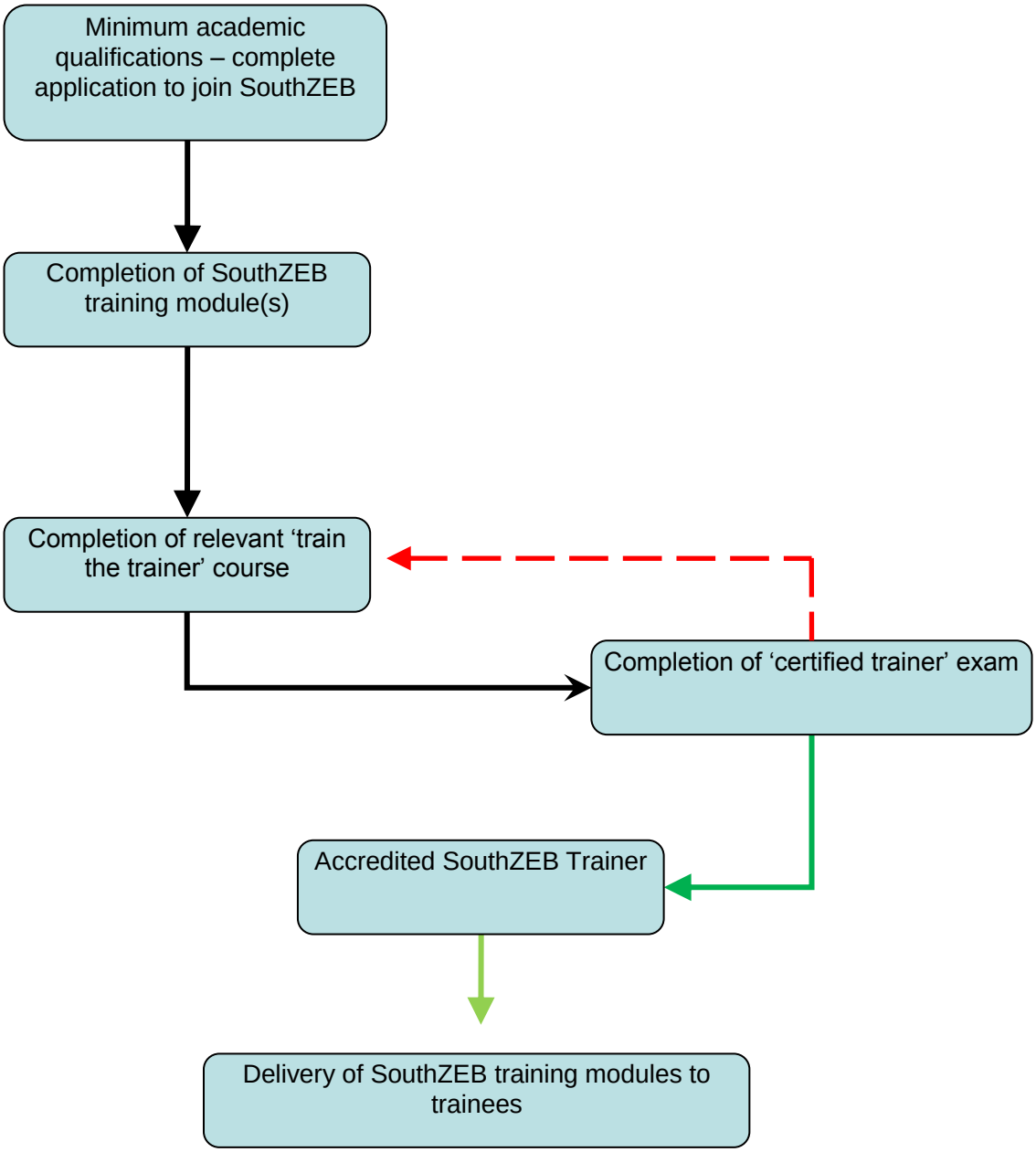


Figure 4.3: Certified SouthZEB Trainer Process

An e-learning platform for remote training using the developed modules will be available, the SouthZEB portal. This enables remote and distance learning for much of course content at the convenience of the trainee, with the exception of the practical workshops.

Within the e-portal, a virtual forum is also accessible to enable collective discussion by building professionals, authorities, certification bodies, vocational trainers and researchers from across Europe. The forum enables users to interact with each other through avatars. In the forum, users can meet, exchange experiences and participate in group activities.

Access to course content material

SouthZEB course content will be accessible to trainees who register to undertake a training module. It is presented in the appropriate language and format for prospective trainees. In order to obtain access, trainees must undergo an online registration process, which will include providing the following relevant information:

- Name
- Company / sole practitioner status (as relevant)
- Address
- Email address
- Phone number
- Qualifications
- Professional memberships (including affiliation and member number)
- Acceptance of the scheme Code of Conduct.

Assessment

For each of the training modules there will be an initial and a final assessment for trainees run by National Partners. The initial assessment will be undertaken through the online SouthZEB portal, where candidates will have access to the test and score after their registration.

The final assessment exams will be undertaken on completion of all elements of the course. The final assessment will be based upon 100 questions per module that should be completed by the candidate.

The final assessment will not be remotely available, and all assessments will be undertaken under exam conditions, as follows:

- Applicants to provide proof of identity (passport, national ID card, photo driving license)
- No communication with any other candidates in any way during the assessment
- All assessment examinations will be independent from the others
- All assessment examinations will be within a set time period (to be undertaken no more than 28 days after completion of the classroom course).

The assessment will involve a further set of multiple choice questions. An agreed pass mark will apply for all final training module assessments.

SouthZEB scheme member certification

SouthZEB applicants who are eligible to join the scheme will be awarded membership based on the completion of at least four training modules and assessments (this must include the basic course – module 1 and the Advanced module – module 2).

The certificate will state the training modules completed and the dates on which they were completed and can be updated as further courses are added.

The certificate will be valid for a period of at least the SouthZEB project duration.

On-going member CPD

All Certified SouthZEB trainees will be required to undertake relevant further CPD training and to keep a record. Members will keep a record of all CPD training undertaken on the portal. The timeframe for CPD is a five year period. The requirements of CPD relate to new technologies, legislation issues and European Directives.

Member conduct

As a requirement of maintaining membership and standing as a 'Certified SouthZEB member', all members must undertake all activities associated with SouthZEB in a legal, ethical and responsible manner.

Learning outcomes

The learning outcomes are.to ensure that SouthZEB members are fully conversant with the Certification Framework, that they understand the entrance criteria, the application process processes and the requirements for training and assessment of competence. Issues such as membership renewal and conduct of members are also to be understood.

5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risk.

Risk - description	Risk Level	Risk management action
Lack of delivery of training materials by partners and complexity of developing four courses (i.e. one for each country).	High	BRE to combine material supplied in each country with own material on certification to create four versions of the course. Hold session on training courses at next partners meeting to resolve any issues; hold special tcfs for WP3 as required. Coordinator action as required.
Poor delivery of classroom training by target country partners and trainers	Medium	BRE can coach the partners in the target countries and the trainers through Q&A sessions by video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low - Medium	BRE will monitor rates and amend course content to support areas where particular groups of questions are not well prepared.
Excessive differences in local issues	Low	BRE will review local material and advise on changes as required.

6 COMMENTS BY EXTERNAL REVIEWER

ITEM	DESCRIPTION	FURTHER NOTES
Training Module	Simulation module	
Does it meet needs of Annex 1	Yes mainly	
Does it accord with Training Essay Plan	It follows the plan set out in four lecture sessions and topics.	
General quality assessment	The overall quality is good. National context to be added.	Action taken to include national aspects
Further comments	None.	
Suggested actions	Importance of national regulations to be taken on board by South Europe partners.	Further content of local nature was developed and added.

APPENDIX F - DESCRIPTION OF MODULE 6: NZEB SIMULATION & DESIGN SOFTWARE

2 WP3 – TASK 2 - TRAINING MODULE 6 – NZEB SIMULATION AND DESIGN SOFTWARES DESCRIPTION

2.1 Preparation and delivery

The course material is for Module 6 is IST-ID responsibility. The Exams are prepared by KEK.

Local issues will be determined and course materials prepared by the partners in the target countries. The contents section below sets out the local issues that need to be prepared by the target country partners.

Delivery of the training course material to trainers will be undertaken in each country by the relevant partners (in accordance with the Description of Work); in Cyprus by the CUT, in Greece by KEK (Euro Training), in Italy by DTTN and Portugal by UMINHO and IST-ID. The trainers will then deliver the courses to the trainees.

2.2 Outline of Module 6 – NZEB SIMULATION AND DESIGN SOFTWARES

Module 6 will present to participants (namely engineers, architects and other building technicians) simulation tools for the design of nZEB and energy efficient buildings. Building energy simulation tools provide the ability to consider energy efficiency measures in buildings by predicting their behaviour under given climatic conditions and usage patterns. These tools help to predict building energy consumption and give the opportunity to compare different design options (use of envelope insulation, advanced glazing, natural ventilation, passive solutions, and high performance HVAC systems among many others).

The estimated duration of the training is 30 hours, divided in pre-course preparation, classroom, post-course study and exam.

2.3 Purpose of the training

The purpose of the training is to present nZEB simulation and design softwares allowing the trainees to practice with one of these softwares. Energy modelling tools provide the possibility to better evaluate different energy saving measures. Briefly, building simulation is the process of using a computer to build a virtual replica of a building. The building is built considering its envelope, internal gains, systems installed, and other important features that influence the building thermal behaviour and its energetic consumptions. The simulation is performed by considering the building through the weather conditions for a certain period of time. Therefore, building simulation can be defined as a way to quantitatively predict the building energy consumptions under a set of defined parameters and inputs. In what concerns to nZEB buildings, energy modelling can analyse and distinguish the best design, technical, changing behaviours and architectural options to reduce energy consumption and/or improve users comfort.

Thus this training module aims to inform and demonstrate to professionals and other stakeholders about the simulation tools available and their versatility and ability to predict and compare different design options regarding energy building consumption towards achieving nZEB buildings.

The training addresses how to use simulation tolls to evaluate the energy consumption impact of building design options.

The aspects that will be covered in this training module are as follows:

- Building simulation overview
- nZEB buildings design approach, strategies and case study
- Creating and defining building and data model required to simulate
- Building energy simulation, namely heating and cooling, natural ventilation, shading and sun exposure, thermal insulation, windows and renewable systems design.
- Scenarios and results analysis.

2.4 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience (course, webinar, self-study or group activity). Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experiences.

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials.

Learning objectives:

- Provide clarity about the purpose of the course;
- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals;
- Establish accountability between the learner and the instructor;
- Help trainers articulate exactly what they want participants to do by the end of the training.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound.

The learning objectives of Module 6 are as follows (specific):

- To understand the advantages of considering building energy modelling in analysing different energy efficiency options.
- To understand the main differences between the modelling software presented in the module, namely its advantages and disadvantages.
- To understand how to define thermal zoning for a given building considering several criteria.

- To define the building geometry, construction solutions and building shadings in the modelling software.
- To consider the internal gains such as equipment, occupation and lighting.
- To understand how to define air infiltration values, natural ventilation and HVAC systems.
- To understand specific simulation inputs such as schedules, run period, sizing zones, etc.
- To analyse the simulation output results and compare different energy efficiency measures for nZEB.

Measurable – learners, after completing the course, are able to run, through open source software, a building simulation towards energy efficient buildings design, establish scenarios and analyse results.

Action – learners will be able to address the implementation of nZEB development within their own work, taking into consideration the thermal comfort conditions. They will also be able to explain to clients, colleagues and other stakeholders the issues involved in nZEB simulation and design software.

Reasonable – PowerPoint slides are supported by reading documents recommended to be studied before and after attending the course and additional material is presented as bibliography through the course; the learning required is commensurate with the objective.

Time-bound – learning will be completed after the training and completion of course reading.

2.5 Learning audience – trainers and trainees – qualifications and experience

The trainers and trainees will be those building professionals involved in the design and construction of buildings, as well as those involved in the building regulation system. Professions will include engineers, architects, building supervisors, site managers and building auditors. Government and local authorities officials involved in the regulation of energy efficient buildings will also be included.

The trainers should be members of a relevant construction profession and have extensive experience, at least 2,5 years' experience in practice of the design and construction of buildings, preferably of energy efficient buildings. Experience of supervision of staff and previous experience in delivering training would also be useful.

The trainees include the building professionals described above, but with any number of years' experience from graduation through to senior company Directors.

3 STRUCTURE OF MODULE 6 – NZEB SIMULATION AND DESIGN SOFTWARES

The estimated duration of the training is 30 hours. The structure of the training course is as follows:

- Preparation – involving an on-line introduction and background reading; the approximate duration is 3 hours;
- Class based training – involving delivery by a trainer of the main components of the training. The delivery will be given by the approved trainer to between 10 and 20 trainees at each session. The approximate duration of the classroom training will be 16 hours by four lectures of 4 hours each;
- Post classroom based training, self-learning and exam preparation. The training will include on-line consultation of the contents of the e-learning platform and self-assessment. The approximate duration of this part of the training will be 8 hours. Attendees will also need to dedicate approximately 2 hours to prepare for the competence assessment. The duration of the post classroom training, self-learning and exam preparation is therefore approximately 10 hours in total.
- Competence assessment – this will be delivered through a one hour written exam that will involve a multiple-choice exam. The assessment will take 1 hour to complete.

3.1 Time Allocation of M6- nZEB Simulation and Design Softwares

It is foreseen to have 16 hours of class based training, distributed per section as follows:

- Session 1 - Getting started – Building energy simulation (2.0 h)
- Session 2 - Net zero energy buildings (2.0 h)
- Session 3 - Getting started / Basic Geometry (SketchUp) (2.0 h)
- Session 4 - Basic Model Data - EnergyPlus (2.0 h)
- Session 5 - Heating and Cooling Design / Natural Ventilation (4.0 h)
- Session 6 - Renewable Energy Systems – EnergyPlus Modelling (4.0 h)
- Exam (1.0 h).

3.2 Course reading material

A number of documents are indicated as necessary (pre-course and post-course) and additional reading material related with energy modelling and nZEB is pointed out:

Clarke, J. A. (2001). “Energy simulation in building design”, second edition, Butterworth Heinemann, Great Britain.

Waltz, J. P. (2000). “Computerized Building Energy Simulation Handbook”, The Fairmont Press, Inc.

Jan L.M. Hensen, Roberto Lamberts (2011). " Building Performance Simulation for Design and Operation". Routledge.

J. Waltz (2000), "Computerized Building Energy Simulation Handbook", Lilburn, Fairmont Press.

Chris P. Underwood, Francis W. H. Yik, (2004) "Modeling Methods for Energy in Buildings", Ed. Blackwell

ATECYR (2008), Guía Técnica de Procedimientos y Aspectos de la Simulación de Instalaciones Térmicas en Edificios, Madrid, 2008

A.M. Malkawi, G. Augenbroe, (2004) Advanced Building Simulation, New York, Spon Press.

University of California (2010) "Getting Started with EnergyPlus - Essential Information You Need about Running EnergyPlus": http://web.stanford.edu/class/cee243/Labs/ePlusTutorial.pdf

EnergyPlus Manuals: https://energyplus.net/documentation

SketchUp Video Tutorials: http://www.sketchup.com/learn/videos/58?playlist=58

OpenStudio Tutorials (video and text): http://nrel.github.io/OpenStudio-user-documentation/

4 CONTENT OF MODULE 6 – NZEB SIMULATION AND DESIGN SOFTWARES

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content has been split into seven sessions. Each session is introduced by the trainer and the connection with the learning objectives and outcomes explained. The sessions vary in timing and content. The course material will be delivered through powerpoint slides (which will be made available to the trainees) or by projection in class of the software user interface.

Additionally, there is a practical exercises using simulation and design softwares.

The sessions are described in this section, including relevance to the objectives and the learning outcomes.

The eight sessions are as follows:

- Session 1 – Getting started – Building energy simulation (2.0 h)

  9. Building simulation overview
  10. EnergyPlus: structure and approaches
  11. EnergyPlus: zoning
  12. Basics of running simulations

- Session 2 - Net zero energy buildings (2.0 h)

  12. NZEB Concept
  13. What is Net Zero Energy?
  14. What are solutions sets?
  15. Design Approach and Strategies
  16. Design Guide Hierarchy and Solution Sets
  17. NZEB Case study

- Session 3 - Basic Geometry- SketchUp (2.0 h)

  13. Introduction to the user interface
  14. Creating a model - adding buildings and blocks
  15. Adding, deleting, moving and cloning objects and other geometry features
  16. Rotate, stretch, drag face and construction line tools
  17. Define roofs geometry
  18. Zoning blocks by drawing partitions, zone types and zoning protocols
  19. Adding shading and adjacency modification using component blocks

- Session 4 - Basic Model Data – EnergyPlus (2.0 h)

  14. Overview of the model data tabs and of data inheritance
  15. Requirements to simulate
  16. Files for Input and Output of EnergyPlus
  17. Simulation Parameters
  18. Location, Climate, Weather File Accessories
  19. Schedules
  20. Material properties definition

21. Surface construction elements
22. General Structure of EnergyPlus basic interface
23. Geometry of the Simulated Building
24. Simulation of shading systems
25. Internal loads
26. Zone Airflow
27. Examples.

- Session 5 - Heating Design, Cooling Design/ Natural Ventilation (4.0 h)

15. Heating and Cooling Design
16. HVAC systems
17. HVAC data (heating, cooling, ventilation)
18. HVAC templates
19. Ideal Loads Air System
20. Zone controls
21. Equipment and connections
22. Setting up and running simulations
23. Analyzing simulation results
24. Examples
25. Ventilation
26. Description of the model implemented in EnergyPlus
27. Displacement ventilation
28. Zone Airflow module
29. Airflow Network module
30. Scheduled ventilation and infiltration
31. Calculate ventilation
32. Analyzing simulation results
33. Examples.

- Session 6 - Renewable systems (2.0 h)

8. EnergyPlus modelling
9. PV sizing
10. Wind generator sizing
11. Load/production energy balance.

- Session 7 - NZEB concepts/scenarios analysis (2.0 h)

3. Natural ventilation
4. Building orientation
5. Thermal insulation
6. Windows
7. Renewable systems
8. Energy Balance – Cases comparison.

- Exam

One-hour written exam.

4.1 Session 1: Getting started – Building energy simulation

Learning objectives of Session 1 - Introduction

The learning objectives of Session 1 are as follows:

- To understand what is building simulation and which models are used.
- To understand how EnergyPlus is structured and which kind of results are obtained.

Content of Session 1 - Getting started – Building energy simulation

The first session of the training module addresses the basics of building energy simulation, namely the following:

- Building simulation overview
- Building simulation models
- EnergyPlus: structure and approaches
- EnergyPlus: zoning
- Basics of running simulations
- Example of using EnergyPlus.

The models used and the EnergyPlus software are presented. The EnergyPlus is used during the course due to its open source nature, free and highly flexible platform for simulation.

In this session it is explained how it is done the zoning of a building and practical examples of the use of the EnergyPlus software.

The session ends emphasizing the importance of reading some contents of the EnergyPlus Manual.

Session 1 – Introduction – estimate duration is 2.0 hours.

Learning outcomes of Session 1

The outcomes from Session 1 will be as follows:

- Knowledge of the principles and models that supports building energy simulation;
- Knowledge of the basics of EnergyPlus simulation.

4.2 Session 2: Net zero energy buildings

Learning objectives of Session 2

The learning objectives of Session 2 are as follows:

- To understand solutions sets, design approaches and strategies towards nZEB buildings.

Content of Session 2

The second session of the training module addresses nZEB buildings, namely:

- NZEB Concept
- What is Net Zero Energy?
- What are solutions sets?
- Design Approach and Strategies
- Design Guide Hierarchy and Solution Sets
- NZEB Case study.

Session 2 presents some examples of nZEB buildings while reinforcing the nZEB concept and nZEB solutions sets. The external factors are explained (such as climate, site, context and microclimate) as well the nZEB design approach and strategies (such as passive design, energy efficiency and renewable energy solutions).

At the end it is presented a feasibility study done for the solar powered net zero energy houses for southern Europe.

Session 2 estimate duration is 2.0 hours.

Learning outcomes of Session 2

The outcomes from Session 2 are as follows:

- Knowledge of design approach and strategies towards nZEB in the Southern Europe.

Bibliography of Session 2

G Carrilho da Graca, A Augusto, M Lerer (2012), “Solar powered net zero energy houses for southern Europe: Feasibility study”, Solar Energy, Vol. 86, pp. 634-646: http://www.sciencedirect.com/science/article/pii/S0038092X1100418X

4.3 Session 3: Basic Geometry- SketchUp

Learning objectives of Session 3

The learning objectives of Session 3 are as follows:

- To understand the procedure to define the basic geometry through SketchUp and EnergyPlus software.

Content of Session 3

Session 3 of the training module addresses the definition of the basic geometry through the simulation software, in particular the following:

- Introduction to the user interface
- Creating a model - adding buildings and blocks
- Adding, deleting, moving and cloning objects and other geometry features
- Rotate, stretch, drag face and construction line tools
- Define roofs geometry
- Zoning blocks by drawing partitions, zone types and zoning protocols
- Adding shading and adjacency modification using component blocks.

The presentation explains the procedure to create the model defining the basic geometry of the building. In this session participants have practical contact with the software and follow the procedure explained in their own computer.

Session 3 estimate duration is 2.0 hours.

Learning outcomes of Session 3

The outcomes from Session 3 are as follows:

- Knowledge of building geometry definition in simulation software.

4.4 Session 4: Basic Model Data - EnergyPlus

Learning objectives of Session 4

The learning objectives of Session 4 are as follows:

- To be able to identify and explain the data needed to construct the model in the EnergyPlus software.
- To identify and understand simulation inputs, outputs and simulation parameters.

Content of Session 4

Session 4 of the training module addresses the definition of the basic model data in the simulation software, in particular the following:

- Overview of the model data tabs and of data inheritance
- Requirements to simulate
- Files for Input and Output of EnergyPlus
- Simulation Parameters
- Location, Climate, Weather File Accessories
- Schedules
- Material properties definition
- Surface construction elements
- General Structure of EnergyPlus nterface
- Geometry of the Simulated Building
- Simulation of shading systems
- Internal loads
- Zone Airflow
- Examples.

The presentation explains in detail the procedure to define a model data in the simulation software. Practical simulation examples are presented. In this session participants have practical contact with the software and follow the procedure explained in their own computer.

Session 4 estimate duration is 2.0 hours.

Learning outcomes of Session 4

The outcomes from Session 4 are as follows:

- Knowledge of model data definition in the simulation software.

4.5 Session 5: Heating and Cooling Design/ Natural Ventilation

Learning objectives of Session 5

The learning objectives of Session 4 of the training module addresses the definition of the HVAC system and natural ventilation in the simulation software, in particular the following

- To be able to identify and define HVAC systems and natural ventilation in the simulation model.

Content of Session 5

Session 5 will address the heating, cooling and natural ventilation design simulation, in particular the following:

- Heating and Cooling Design
    - HVAC systems
    - HVAC data (heating, cooling, ventilation)
    - HVAC templates
    - Ideal Loads Air System
    - Zone controls
    - Equipment and connections
    - Setting up and running simulations
    - Analyzing simulation results
    - Examples
- Ventilation
    - Description of the model implemented in EnergyPlus
    - Displacement ventilation
    - Zone Airflow module
    - Airflow Network module
    - Scheduled ventilation and infiltration
    - Calculate ventilation
    - Analyzing simulation results

- Examples

The presentation explains in detail the procedure to define a HVAC system and natural ventilation model in the simulation software. Practical simulation examples are presented. In this session participants have practical contact with the software and follow the procedure explained in their own computer.

Session 5 estimate duration is 4.0 hours.

Learning outcomes of Session 5

The outcomes from Session 5 are as follows:

- Knowledge of HVAC systems and natural ventilation model definition in the simulation software.

4.7 Session 6: Renewable Energy Systems – EnergyPlus Modelling

Learning objectives of Session 6

The learning objectives of Session 6 are as follows:

- To understand the procedure and be able for sizing PV and wind generator through EnergyPlus software and analyse results.

Content of Session 6

Session 6 will address renewable energy systems and their design simulation through EnergyPlus, in particular the following:

- EnergyPlus modelling
- PV sizing
- Wind generator sizing
- Load/production energy balance.

The presentation explains the procedure to define a renewable energy system, namely PV and wind generator, basic model in the simulation software. Practical simulation examples are presented. In this session participants have practical contact with the software and follow the procedure explained in their own computer.

Session 6 estimate duration is 2.0 hours.

Learning outcomes of Session 6

The outcomes from Session 6 are as follows:

- Knowledge of basic renewable energy systems modelling, namely PV and wind generator, through EnergyPlus software and analyse results.

4.8 Session 7: NZEB concepts / scenarios analysis

Learning objectives of Session 7

The learning objectives of Session 7 are as follows:

- To be able to understand and explain different scenarios analysis regarding natural ventilation, building orientation, thermal insulation, windows and renewable energy systems.

Content of Session 7

Session 7 will address nZEB concepts and related scenarios through EnergyPlus simulation, in particular the following:

- Natural ventilation
- Building orientation
- Thermal insulation
- Windows
- Renewable systems
- Energy Balance – Cases comparison.

The presentation explains the procedure to define different scenarios analysis related with nZEB concepts in the simulation software. Practical simulation examples are presented. In this session participants have practical contact with the software and follow the procedure explained in their own computer.

Session 7 estimate duration is 2.0 hours.

Learning outcomes of Session 7

The learning objectives of Session 7 are as follows:

- Knowledge and understanding of creation and analysis of different scenarios regarding nZEB concepts, through EnergyPlus software.

5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risk.

Risk – description	**Risk Level**	**Risk management action**
Lack of delivery of training materials by partners and complexity of developing four courses (i.e. one for each country).	High	IST to combine material supplied in each country with own material to create four versions of the course, one for each target country. Hold sessions on training courses at partners meetings to resolve any issues; hold special tcfs for WP3 as required. Coordinator action as required.
Poor delivery of classroom training by target country partners and trainers	Medium	IST can coach the partners and the trainers through Q&A sessions by video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low - Medium	IST will monitor rates and amend course content to support areas where particular groups of questions are not well prepared.
Excessive differences in local issues	Low	IST will review local material and will advise on changes as required.

6 COMMENTS FROM EXTERNAL AND INTERNAL REVIEWER

ITEM	REVIEW
Training Module	Module 6 – simulation and design software.
Does the subject matter match the description – explain reasons	Partially for the following reasons. • The learning objectives are not supported by the material as presented in the slides. The former implies the imparting of essential knowledge relating to the 'why and how' of modelling & simulation, while the slides arbitrarily describe the mixed resolution model making and calculation procedures of EnergyPlus (this is not to imply that EnergyPlus should not be the featured tool). Answer: We will introduce new slides to clarify the why and how of simulation. We choose EnergyPlus due to its open source nature (in combination with OpenStudio we obtain a free and highly flexible platform for simulation). • The brief states that the "module will include exercises with different simulation tools" while only one tool, EnergyPlus, is included. While Ecotect is mentioned in the brief it is not included in the slides (in any event Ecotect is not a simulation tool). Answer: Ecotect is no longer available. For this reason we excluded this tool. • There is an inappropriate mix of concepts between nZEB performance assessment and simulation tool features; these should be separated out so that the former is independent of the tool used. Answer: We will improve the separation of concepts in the revised slides.
Would you recommend this training course for use in SZEB – explain reasons	While the material may be a useful introduction to the use of EnergyPlus, it does not advance the art of simulation as applied to low energy buildings. The material as presented is available in existing teaching and learning materials. Answer: Could you please indicate where we can find a package that is ready and is better than what we produced for this purpose?
General quality assessment – please comment	On the basis of the slide material alone, the course does not appear to be of high quality. It comes across as a collection of technical concepts taken from various publications and user manuals with little attempt to design a new teaching & learning resource that addresses its own brief. It is acknowledged that the quality might rise appreciable due to lecturer input. If this is the case then this additional input should be captured in the form of course notes. Answer: We will improve the material in the revision and in the lectures.
Further comments	Simulation is the process of subjecting a building model to the complex influences it will experience in practice in order to ensure robust operation when build. It is not a method to predict performance. The proposed material is more a recipe for engineering calculation and should perhaps be labelled as such.

	Answer: In light of the short duration of the course we took a direct approach that focuses on performance. We feel that it is an effective approach. It is important to clearly state the ideal target of simulation – all domains treated dynamically on the basis of time evolving model parameters – and then describe the limitations of a particular program in these regards. Answer: The main limitation in our case is user energy demand profile and not simulation. We should keep this in mind and discuss it in the course so that the students don't over rely on the simulation results.
Suggested actions for this module	Separate the material that relates to the modelling and simulation of nZEB buildings from that which relates to the use of the specific tool, EnergyPlus. In the former case, important issues are model resolution, model quality assurance, thermodynamic process representation, integrated performance assessment, performance criteria, design evolution through iterative model refinement, and changes to work practice. In the latter case, the important issues are how to access the required program features to undertake a dynamic, integrated performance assessment and how to accommodate tool shortcomings (e.g. through sensitivity analysis); else the approach is not simulation and should not be labelled as such. Answer: We will improve the separation of concepts in the course. We want to take a practical, hands on, approach to simulation of nZEB's.
Please add comments on specific sections and slides here.	The slides relating to the structure and theory of EnergyPlus are confusing because they present unexplained complexity (e.g. 1st lecture, slides 15 & 16), mix dynamic and steady-state concepts (e.g. 1st lecture, slides 30-34), and cover well known issues (e.g. surface heat balance) while excluding important new topics (e.g. demand management, demand/supply matching and power quality). There are many slides, such as 1st lecture, slides 30, which impart no helpful message: why is a typical floor used, why is the zoning scheme as depicted when the space is open plan, where are all the other objects, etc.? The material of the 2nd lecture is partially unhelpful because it merely reiterates the features of EnergyPlus with no comment on where these are appropriate or inappropriate. The material of the 3rd lecture is partially unhelpful in that it does not clearly describe HVAC system model making and building connection, implies steady-state treatment throughout, and treats important phenomena in a rudimentary manner (e.g. fluid and electrical power flow). Further, the presented results are partial with no guidance given on how such information can be linked to design decision-making. The material of the 4th lecture is partially unhelpful in that it treats building-integrated renewable technologies in a rudimentary manner, while excluding significant issues such as load matching, voltage regulation, power quality and running cost. It also implies a modelling procedure that relies on the user to *a priori* size components. Answer: As in any course, the slides are a base for the lectures and do not convey the full picture. We will attempt to address as many issues as possible

	in the revision.

ITEM	DESCRIPTION	FURTHER NOTES
Training Module	nZEB simulation and design software module (Task Leader: IST – ID)	
General quality assessment	Good quality and comprehensive presentations.	
General comments	• According to Training Essay Plan -> ECOTECT program is not presented in the slides. However, it is acknowledged that there is not adequate time for ECOTECT to be analysed also in depth based on the hours provided for in-classroom training. Answer: ECOTECT is no longer available to the public, so we had to reformulate and find alternative simulation tools. • According to Annex I (Grant Agreement) -> the content meets the requirements set.	It should be clarified whether a workshop will be executed also, as described in Grant Agreement.
Suggested actions	Simultaneous workshop, where the tasks presented in the slides will be executed real – time in the simulation program (if not already foreseen).	The time for the training in the classroom should be maintained according to the training essay plan and the simultaneously execution of the tasks in the simulation program perhaps may present a risk in preserving the timing.
Specific comments on course content	Perhaps it could be useful if there could be ~5 slides mentioning ECOTECT (or another simulation program, such as TRNSYS), their basic characteristics and perhaps basic differences to EnergyPlus. Answer: We will add slides that mentions other simulation tools.	
Any other comment		

ITEM	DESCRIPTION	FURTHER NOTES
Training Module	Simulation module	
Does it meet needs of Annex 1	Yes mainly	
Does it accord with Training Essay Plan	It follows the plan set out in four main lecture sessions and seven topics. It is not clear that Lecture 4 follows the plan, and this needs to be clarified. Answer: We will look at lecture 4 in the revision.	
General quality assessment	The overall quality is good. The presentations do rely heavily in places on screen shots and this lends itself to the trainer having a very good knowledge of the model. There are no notes to the slides, but the need to be well versed in EnergyPlus may be of detriment to the trainers/trainees. Answer: We rely on OpenStudio as the base interface, we will only discuss a minimum set of features in EnergyPlus.	Address how to ensure that trainers will be competent, will they require access to EnergyPlus and is this a cost for a license. Answer: There are no costs for the tools used in the training. They are free download, we will add a slide on this.
Further comments	The training relies upon the use of Energy Plus. Do all those slides that refer to EnergyPlus need to do so, or are the issues generic enough to remove some of these references. The training essay plan does not refer specifically to EnergyPlus or any other type of software. Answer: To make the training more effective we choose a tool so that the students can perform simulations in a consistent way. Once they learn this tool they can easily transition to other tools.	
Suggested actions	Consider ways to remove some of the references to Energy Plus. Reference other models and the advantages/disadvantages of their use. Answer: We will add slides that mentions other simulation tools.	Is reference to the EPBD useful. Answer: We think so, given its focus on nZEB.

APPENDIX G - DESCRIPTION OF MODULE 7: LOW CARBON TECHNOLOGIES & AUTOMATION

2 WP3 – TASK 2 - TRAINING MODULE 7 – DESCRIPTION

2.1 Outline of module 7

Module 7 aims to present to designers, developers, specifiers and policy makers (e.g. architects, engineers, and municipality employees), the range of low carbon technologies crucial to helping achieve ZEBs.

The module includes an overview of various low carbon systems suited to the target countries and highlights key design, installation, operation and maintenance issues, as well as introducing how to assess the financial performance and cost effectiveness of the different systems. The module also introduces building automation systems, their purpose and classification and explains their importance in ensuring the successful integration and operation of the low carbon technologies and building energy systems. The module also introduces the concept of a cost-optimal assessment methodology and the requirement for policy-makers and designers to take into account the global lifetime costs of buildings to shape their energy design and performance. The global cost calculation method “EN 15459: Energy performance of buildings – economic evaluation procedure for energy systems in buildings” is also introduced.

This training module has been coordinated, designed and planned by BRE, but partners from each country (Cyprus, Greece, Italy and Portugal) have revised and/or developed specific training material related to their own country. As a result the approach changes between countries in order to allow for local regulations, traditions and opportunities to be fully explained.

The estimated training duration is 20 hours. It is addressing the needs of engineers, architect, building developers and municipality employees.

2.2 Purpose of the training

The purpose of the training is to inform building professionals and other stakeholders on the need for an effective energy strategy for near Zero Energy Building design, and to introduce a range of technologies and concepts that these professionals need to consider and/or be aware of.

The training also addresses key issues design, installation, control, operation and maintenance issues relating to common low carbon and renewable energy technologies as typically employed in nZEB buildings, given that an nZEB is a very low energy building that balances its low energy consumption by the use of renewable energy generated on site. The training also introduces and highlights evolving energy storage systems as an important mechanism to contribute to nZEB solutions.

As well as introducing a range of technologies the training also highlights the need for building professionals to understand the principles for evaluating and comparing the relative merits of these (potentially competing) technologies to ensure that an integrated, complimentary, and user-friendly design solution can be delivered that meets regulatory requirements, satisfies user demands and is cost effective at meeting the energy demands of the building. A number of practical exercises enables learners to evaluate individual technologies in terms of energy, cost and carbon emission impacts.

The training further develops the concept of cost and the importance of designing nZEBs with consideration for whole life performance, by introducing the concept of cost-optimality and the global cost calculation method “EN 15459: Energy performance of buildings – economic evaluation procedure for energy systems in buildings”.

Additionally, given that nZEBs are likely to have a high level of energy efficiency the training also cover the equally important topic of building automation and control. This section highlights the importance of having effective control in place to ensure that the energy demands are maintained, and controlled, in accordance with the design principles; thereby enabling the low carbon and renewable energy technologies to meet the remaining energy demand efficiently.

2.3 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience, such as a course, webinar, self-study or group activity. Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experience(s).

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials. Learning objectives:

- Provide clarity about the purpose of the course.
- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals.
- Establish accountability between the learner and the instructor.
- Help trainers articulate exactly what they want participants to do by the end of the training.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound.

The learning objectives of Module 7 are as follows:

- Objective 7.1: Specific - to understand the importance of low carbon technologies in contributing to a near zero energy building and to be able to offer appropriate solutions whilst considering key design, installation, operation and maintenance issues of various low carbon technologies, and complimentary systems, suited to the target countries (i.e. PV, small scale wind generators, solar thermal and heat pump/cooling, energy storage).
    - Measurable – learners are able to describe various low carbon technologies and energy systems show understanding of their principles and their relative relationship to nZEB development in their own country and at other locations around Europe.
    - Action – learners will be apply to recommend/apply appropriate energy system design advice for a given location, site, building design/use, upon completion of the training.
    - Reasonable – powerpoint slides are supported by learning documents available via the website, the learning required is commensurate with the objective.
    - Time-bound – learning will be completed after the training and completion of course reading.
- Objective 5.2: To understand the concept of lifetime costs, cost optimality and the nature of building system information that is needed to evaluate a building in accordance with the EN 15459 standard.
    - Measurable – learners are able to describe the issues affecting lifetime cost, the concept of cost optimality, the nature of the calculations underpinning EN 15459 global cost

calculation methodology and the types of information typically required to facilitate such an assessment.

- Action – learners will be able to apply awareness of the importance whole lifecycle costs within their own work, enabling them to consider and reduce the impacts of future developments.
- Reasonable – powerpoint slides are supported by learning documents available via the website, the learning required is commensurate with the objective.
- Time-bound – learning will be completed after the training and completion of course reading.

- Objective 5.3: To understand the importance of monitoring, building automation, control and optimisation in delivering effective nZEBs.
  - Measurable – learners are able to explain the need for effective control of building energy systems, and key control concepts / options for common building energy loads including classification of control system as defined within EN 15232:2012 - Energy performance of buildings – Impact of Building Automation, Controls and Building Management.
  - Action – learners will be able to apply awareness of building automation systems within their own work, enabling them to consider the delivery of satisfactory internal environments for occupants with the importance of effectively manging energy use within nZEBs
  - Reasonable – powerpoint slides are supported by learning documents available via the website, the learning required is commensurate with the objective.
  - Time-bound – learning will be completed after the training and completion of course reading.

2.4 Learning audience – trainers and trainees – qualifications and experience

The trainers and trainees are those building professionals involved in the design, development, specification and construction of buildings, as well as those involved in operation and facility management. Professions include architects, architectural technologists, engineers (mechanical and structural), building supervisors, developers and facility managers. Government and local authority officials involved in the regulation of near zero energy buildings are also included.

The trainers should be members of a relevant construction profession and have at least 2,5 years' experience in practice of the design, development or construction of low carbon buildings / renewable energy technologies / building energy controls and monitoring systems; ideally with near zero energy buildings. Experience of supervision of staff and previous experience in delivering training are also useful.

The trainees include the building professionals described above, but with any number of years' experience from graduation through to senior company Directors.

3 STRUCTURE OF MODULE 7

The structure of the 22.5 hour training course is as follows:

- Preparation – involving an on-line introduction and background reading, consisting of 2 hours background preparation on low carbon technologies, and 0.5 hours on both controls and whole life costs. The approximate duration is 3 hours in total.
- Class based training – involving delivery by a trainer of the main components of the training. The delivery is given by the approved trainer to between 10 and 20 trainees at each session. The approximate duration of the classroom training is 11 hours; this is split as 7 hours on the energy strategy, low carbon technologies and energy storage aspects; 2 hours on cost optimality and EN 15232:2012 and 2 hours on building automation and lifetime costs. Class room training, per section, is as below. The approximate duration is 11 hours in total.
    - Session 1 - Introduction (0.5h)
    - Session 2 - Photovoltaics (2h)
    - Session 3 - Small Scale Wind (1.5h)
    - Session 4 – Solar Thermal (2h)
    - Session 5 – Energy Storage (1h)
    - Session 6 – Cost Optimal and EN15459 (2h)
    - Session 7 – Building Controls and Automation (2h)
- Post classroom based training, self-learning and exam preparation. The training and self-learning will include review of classroom material, additional reading on the issues covered within the module content and completion of a number of supporting exercises (i.e. examples for the learners to assess the cost effectiveness of various renewable energy technologies). The approximate duration of this part of the training is 3 hours. Attendees will also need to dedicate approximately 2 hours to prepare for the competency assessment. The duration of the post classroom training, self-learning and exam preparation is therefore approximately 5 hours in total.
- Competence assessment – this will be delivered through a one hour written exam that will involve a multiple-choice exam. The assessment will take 1 hour to complete.

3.1 Course reading material

Pre-classroom

A number of papers are provided as an introduction to renewable energy technologies, building controls and lifecycle cost issues, as follows:

Renewable Energy Technologies:

Renewable energy sources – a technology overview (Carbon Trust publication CTV010): https://www.carbontrust.com/media/7379/ctv010_-_renewable_energy_sources.pdf

Building Controls and Automation:

Building controls – a technology overview (Carbon Trust publication CTV032): https://www.carbontrust.com/media/7375/ctv032_building_controls.pdf

Life Cycle Costs / Cost Optimal:

Energy Performance of Buildings Regulations: http://www.epbd-ca.eu/

https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

http://www.eceee.org/policy-areas/buildings/EPBD_Recast

IEE-Cense, Information paper (P160) on EN 15459 - Economic evaluation procedure for energy systems in buildings: http://www.buildup.eu/en/practices/publications/information-paper-en-15459-economic-evaluation-procedure-energy-systems

National building regulations / standards relevant to energy assessment, low carbon technologies, building controls, compliance calculations and the energy performance of buildings.

Cyprus

ΚΔΠ 33/2015 - On the Regulation of the Energy Performance of Buildings (Methodology on the Energy Assessment of Buildings) Decree 2015

ΚΔΠ 343/2013 – On the Regulation of the Energy Performance of Buildings (Methodology for the calculation of the Cost Optimal minimum Requirements on the Energy Performance of Buildings) Decree 2013

ΚΔΠ 386/2013 – On the Regulation of the Energy Performance of Buildings (Requirements on New Technical Building Systems installed in existing buildings or building units and technical systems that are replaced or upgraded) Decree 2013

ΚΔΠ 366/2013 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB) Decree 2014

Cyprus Energy Service, “Guide on near Zero Energy Buildings”, 2014.

Greece

Greek Law 3661/2008, issued on the 19th of May 2008

Regulation for Energy Efficiency of Buildings (KENAK) issued in 2010 (Official Gazette Bulletin B’ 407/09-04-2010), based on the Greek Law 3661/2008

Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B' 1387-2010 and 1413-2012

Greek Law 4122/2013 "Energy Performance of Buildings – Transposition of Directive 2010/31/EU"

Italy

European Parliament and the Council of the European Parliament (2010). Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast).

UNI EN 15251:2007 - Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

D.L. 63/2013 Disposizioni urgenti per il recepimento della Direttiva 2010/31/UE del Parlamento europeo e del Consiglio del 19 maggio 2010, sulla prestazione energetica nell'edilizia per la definizione delle procedure d'infrazione avviate dalla Commissione europea, nonche' altre disposizioni in materia di coesione sociale. (13G00107) (GU Serie Generale n.130 del 5-6-2013)

Bull J.W., Life Cycle Costing for Construction, 2003

Utica G., La stima sintetica del costo di costruzione, 2011

Portugal

Aelenei L, Gonçalves H, "From Solar Building Design to Net Zero Energy Buildings: Performance Insights of an Office Building" (2014): http://www.sciencedirect.com/science/article/pii/S1876610214004020

Solar thermal systems: http://www.painelsolartermico.com/sistemas-solares-termicos/

Tubular vacuum collectors: http://www.newhome.com.br/HTMLs/Ekohome/Solar/T%C3%A9rmico/ColetorTubVac.htm

Use of solar collectors for water heating in the Domestic Sector: http://www.aguaquentesolar.com/publicacoes/9/domestico.pdf

Solar XXI building: http://www.lneg.pt/download/4078/BrochuraSolarXXI_Dezembro2005.pdf

Photovoltaic technology: http://paginas.fe.up.pt/~ee03096/index_ficheiros/Page830.htm

Post classroom

Further study on various aspects, and assessment tools, introduced during the module, and additional references for further detailed study, is provided or referenced. This includes:

Provided:

UK Energy Saving Trust publication "CE 72", Installing small wind-powered electricity generating systems - guidance for installers and specifiers: https://tools.energysavingtrust.org.uk/scotland/Generating-energy/Information-for-installers/Installing-small-wind-powered-electricity-generating-systems-CE72

UK Energy Saving Trust publication "CE 131", Solar water heating systems – guidance for professionals: http://tools.energysavingtrust.org.uk/Publications2/Housing-professionals/Microgeneration-

Renewables/Solar-water-heating-systems-guidance-for-professionals-conventional-indirect-models-2006-edition

UK, DTi, Guide to the installation of Photovoltaics in Buildings, second edition: https://www.bre.co.uk/filelibrary/pdf/rpts/Guide_to_the_installation_of_PV_systems_2nd_Edition.pdf

UK Carbon Trust publication, CTC738 - Small-scale wind energy Policy insights and practical guidance: https://www.carbontrust.com/media/77248/ctc738_small-scale_wind_energy.pdf

UK Carbon Trust publication, CTG038 – a place in the sun – Lessons learned from low carbon buildings with photovoltaic electricity generation: https://www.carbontrust.com/media/81357/ctg038-a-place-in-the-sun-photovoltaic-electricity-generation.pdf

Links provided:

2002: Energy Performance of Buildings Directive (EPBD), (Directive 2002/91/EC,EPBD)

2010: recast EPBD, (Directive 2010/31/EU)

UK, Microgeneration Certification Scheme (including design, installation, operation and maintenance standards): http://www.microgenerationcertification.org/

European Commission PVGIS – European solar resource maps and tools: http://re.jrc.ec.europa.eu/pvgis/countries/countries-europe.htm

Additional referenced material

IEE, Technology Roadmap Solar Photovoltaic Energy - 2014 edition: https://www.iea.org/publications/freepublications/publication/TechnologyRoadmapSolarPhotovoltaicEnergy_2014edition.pdf

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EU Roadmap for moving to a competitive low carbon economy in 2050 (COM, 2011a)

The Commission Cost-Optimality Delegated Regulation (EC, 2012a)

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Italy

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Iannone F., Quaranta G.G., Impianti solari fotovoltaici. Aspetti progettuali, criteri di scelta, problematiche installative di gestione e manutenzione, esempi di documentazione di progetto, 2013

Caffarelli A., de Simone G., Principi di progettazione dei sistemi solari fotovoltaici, 2010

Caffarelli A., de Simone G., Principi di progettazione dei sistemi solari eolici, 2010

UNI EN 15459:2008 - Prestazione energetica degli edifici - Procedura di valutazione economica dei sistemi energetici degli edifici

Portugal

Solar thermal systems: http://www.adene.pt/sites/default/files/documentos/10see-06-sist-st.pdf

Solar photovoltaic systems: http://www.adene.pt/sites/default/files/documentos/10see-10-sist-fotovoltaico.pdf

4 CONTENT OF MODULE 7

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content has been split into one and a half days. Each session is introduced by the trainer and the connection with the learning objectives and outcomes explained. The sessions vary in timing and content. The course material is delivered through powerpoint slides, which are made available to the trainees.

On Day 1 the course will involve one day, classroom based training, introducing on a range of low carbon energy technologies and supporting energy storage mechanisms of key importance to nZEB design and operation. On Day 2 an additional half-day, classroom based, training session will focus upon the concept of whole life performance of buildings (and its assessment), as well as building energy system control and automation..

The sessions are described in this following sections, including relevance to the objectives and the learning outcomes.

4.1 Session 1: Introduction

Learning objectives:

- To introduce attendees to significance of renewable energy sources, energy efficiency and low carbon technology in the context of delivering nZEBs.
- To draw attention to the need for an effective, site specific, energy strategy for nZEB building design.

Content

Session 1 provides an introduction to the EPBD2 and the challenges that it poses for the energy performance of buildings. The definition of nZEB from EPBD2 article 2 is then presented to highlights the import role that an effective energy strategy, energy efficiency and renewable energy sources has to play. In particular, the training module addresses the following:

The session starts with an introduction to the Energy Performance of Building Directive (EPBD) (2002) and a recap of the initial requirement for member states to introduce energy certifications schemes. It progresses to then introduce the Energy Performance of Building Directive (recast) (EPBD 2) (2010), the evolution of the original EPBD, which has introduced tough new challenges including requirements that:

- New and retrofitted building to be nZEB by 2020 (3018 for public buildings)
- A cost-optimal methodology must to be implemented by each member states, to set minimum requirements for both the envelope and energy systems of buildings.

To address the question “What is nZEB?”; the EPBD2 Article 2 nZEB definition is presented, as defined below, and the importance of renewable energy technologies and effective energy strategy is then highlighted.

> *“[..] ‘nearly zero-energy building’ means a building that has a very high energy performance [..]. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby.[..]”*

The general concept of nZEBs is then introduced and it is explained that efficiency comes first, and renewables last. Furthermore, the following energy strategy development hierarchy is discussed, anmely:

1. Load reduction – via passive design
2. System efficiency – meet remaining loads as efficiently as possible
3. Regenerative systems – use waste energy
4. Renewable energy – generate power on-site / nearby from suitable sources
5. (Enable energy management to ensure efficient, and long-lasting, operation)

It is highlighted that module 7 (this module) focusses predominantly on the item 4 – Renewable Energy Systems that can help achieve NZEB.

nZEB energy strategy (at site level) is then addressed, and the importance of early consideration of a site specific, energy strategy (that maximises site opportunities and which is complimentary to a propsed building design and use) is discussed. The following issues are highlighted: site layout and shape (e.g. passive solar design, ventilation strategy options), solar access (e.g. PV generation potential, need for shading, glare), ground conditions (e.g. for potential for ground cooling), available wind resource (cooling, renewable power generation, natural ventilation

nZEB energy strategy (renewables) is then addressed and the concept of renewables is introduced and the fact that many renewables need to be considered / chosen based on an awareness of a number of factors including:

- Site energy demands; Site constraints; Cost effectiveness; Energy / Carbon saving potential; What fuels are being displaced?; Attitude to risk; Promotional value e.g. schools; Changing financial/subsidy landscape.

  The module highlights CIBSE technical memorandum 38 (TM38) – renewable energy sourced for buildings – as one tool and source of independent information that can assist in the selection of appropriate renewables. It also references other assessment and edecision support tools including US DoE, NREL, ASHRAE, RETScreen, etc.

nZEB energy strategy (option appraisal) is then addressed and the concept of undertaking an option appraisal exercise is highlighted to enable a comparison between various technically feasible options, as a means of providing an audit trail on effective sustainable energy strategy development.

The session concludes by highlighting the technologies and concepts that will be addressed in the sessions that follow.

Learning outcomes

The outcomes from Session 1 will be as follows:

- Knowledge of the existence of a legislative requirement for nZEBs.
- Knowledge of the EPBD definition of NZEBs and the reference to renewable energy sources.
- Knowledge and awareness that demand reduction, efficiency, and regenerative system should be applied before renewables.
- Knowledge and awareness that a well devised energy strategy is essential to delivering a successful nZEB.

4.2 Session 2: Photovoltaics

Learning objectives

- To introduce attendees to the concept of renewable energy generation via photovoltaic (PV) systems. To understand the theory of how electricity is generated and the factors influencing generation and the availability and magnitude of solar resource.
- To present the different types of PV panel, discuss their relative merits and present the different classification of (evolving) PV systems (i.e. building mounted PV / building integrated PV).
- To introduce means of calculating energy performance / generating potential of PV systems and thus assess their energy, carbon and cost impact.
- To introduce key design, installation, operation and maintenance considerations.

Contents

The session includes the following:

Introduction to the technology / overview of common system types:

The sessions starts by providing a brief overview of the global PV market, highlighting that the world has added more PV capacity in 2010-2014 than in the previous 40 years and that PV module prices have divided by 5 and overall PV system prices have reduced by a third over the last 6 years in most global markets (source: international energy agency).

Resource / theory

The session presents a short history of PV as well highlighting the magnitude of solar energy that is available on the earth, including a comparison in magnitude versus fossil and nuclear fuels and other renewable forms of energy. The European Commission Photovoltaic Graphical Information System (PVGIS) is presented as a reputable source of solar resource maps for European countries. Seasonal variations in solar access is highlighted in terms of the impact of site latitude and example images are also presented to highlight the impact of PV array orientation and inclination on the efficiency of PV generation (for a specific location). The theory behind how PV modules generates power is introduced.

System components

PV module types (monocrystalline, polycrystalline and amorphous) are introduced. Guidance relating to their relative efficiency, durability (years), applications, advantages and disadvantages is discussed.

System classifications

The way in which PV modules and PV systems are classified and rating is discussed. This includes an explanation of the term “watts peak” and how this relates to the performance of PV modules as tested under “standard test conditions (STC)”. The conditions defined for the STC tests are also highlighted so that the attendees understand that the Watts peak performance of modules vary as a results of solar irradiance, air temperature and air mass density. Some local examples are provided to reinforce the typical energy generation potential of a 1 kilowatt peak module at different European locations. The sessions continues by introducing different classifications, and presenting some examples, of PV systems including: Building Applied PV (BAPV), Building Integrated PV (BIPV), as the two main types of building-related energy applications for PV. The concept of BIPV is further expanded to highlight a number of sub-product types and building applications (e.g. roofs, windows, overhead glazing, facades, sun shades, etc.).

Design, installation, operation and maintenance:

Fundamental design considerations are highlighted such as the needs for early consideration of BIPV in the design process and also the need for effective ventilation to ensure maximum efficiency of the modules, as well as the need to balance functionality, cost, site suitability, client preferences, etc. Further examples of BIPV are presented. The importance of design team coordination, and the extent of trades on whom the inclusion of a PV system can impact on, is also highlighted

System configuration / design issues are then covered. This includes an overview of grid connected PV system (single and 3 phase systems). Graphics and electrical schematic diagrams are used to highlight key components and important design considerations (e.g. safety systems). Key design consideration such as shading, available roof area, orientation/inclination, sun angle, mounting, structural design, heating, access, grid connection process, metering and planning approval / local restrictions, are highlighted and discussed. Operation and maintenance issues are then also introduced.

PV standard and guidance are introduced in order to provide attendees with suitable reference to key document and best practice requirements. The IET Code of Practice for grid connected PV installation is highlighted.

Energy Performance:

A means of manually estimating the performance of a PV system is introduced. Attendees are introduced to an equation for estimating energy generation potential of PV systems. The variables in the equation are discussed in order to enable attendees to understand the variables and how these may impact on total annual energy generation, as well as understand what information they need to identify / collect / obtain in order to facilitate an assessment. Attendees are also advised that the equation based method is only an approximate method and that more detailed calculation methods are available (e.g. PV design software). A worked example of the calculation is presented. A cost appraisal example is also provided in order to provide attendees with an example process that they can use to assess the cost effectiveness of a PV system. This includes consideration of avoided energy costs, income from exported energy and income from any financial incentives for renewable power generation. Financial incentives for PV generated power (e.g. feed-in-tariffs) are discussed where relevant to specific countries. A simple payback calculation is then also presented.

The EU Joint Research Council PVGIS tool (see the figure below) (http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php) is presented as a robust means of obtaining solar radiation estimates as well as providing a tool to calculate energy generation potential in line with the equations presented earlier.

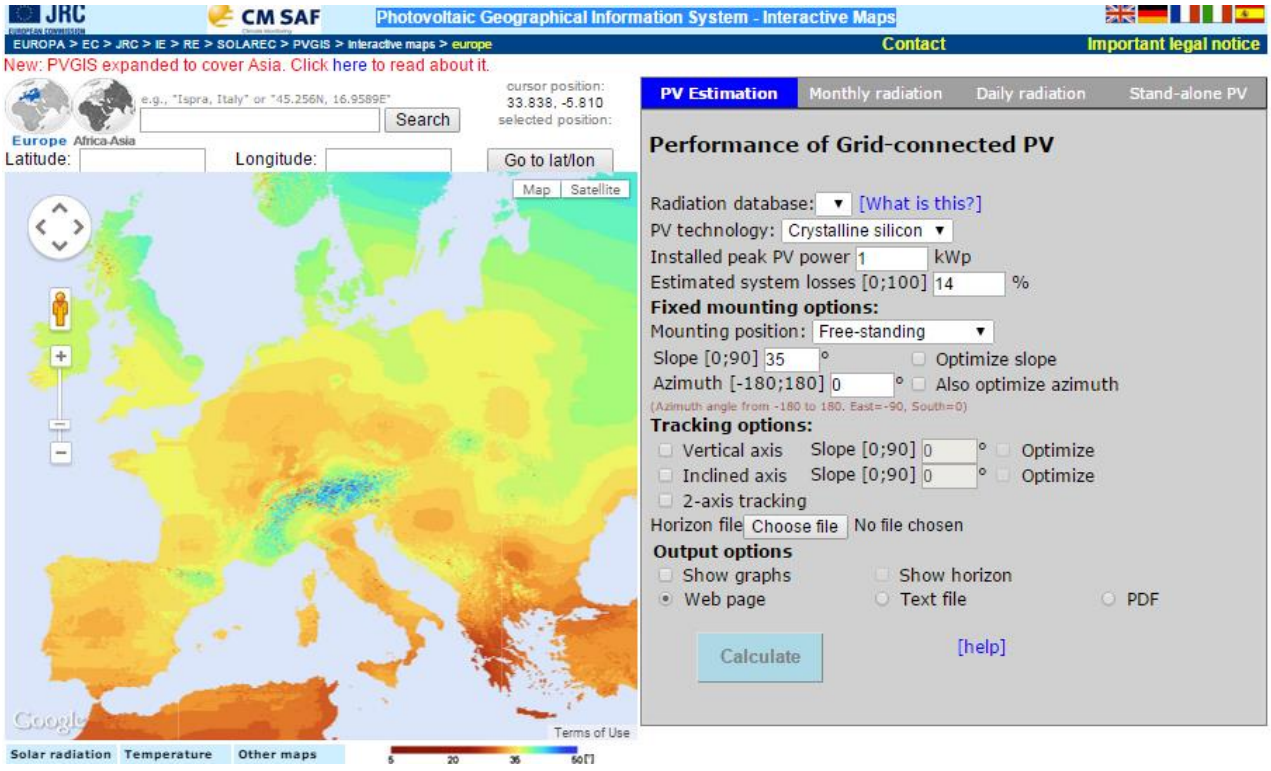

Figure 1: The EU Joint Research Council PVGIS tool

Further information:

Further sources of information on photovoltaic systems is then highlighted including the global solar council, the European Photovoltaic Industry Association (EPIA), as well as other, country specific, PV trade bodies, associations and agencies.

Exercises:

The presentation material is supplemented with a small number of questions and practical exercise material for attendees to apply their new learning, including two case scenarios requiring attendees to carry out calculations to estimate energy generation, carry out a payback calculations and to consider and discuss key issues affecting PV feasibility.

Learning outcomes

The outcomes from Session 2 will be as follows:

- Knowledge on how PV systems operate and the types of systems available, including awareness of advantages / disadvantages of the various system types.
- Knowledge and awareness of available solar resource and the local and global potential for PV generation including awareness of basic energy performance calculation methods, and available resource maps, design and assessment tools to assist in assessing PV feasibility, as well as system energy, carbon and cost impact.
- Gain knowledge in respect of the key design, installation, operation and maintenance considerations, thereby enabling learners to apply this knowledge appropriately in their profession.

4.3 Session 3: Small Scale Wind

Learning objectives

- To introduce attendees to the concept of renewable energy generation via (small scale i.e. equivalent to a rotor diameter < 16m, or a maximum rating of ~ 50kW) wind turbine generator (WTG) systems. To understand the theory of how electricity is generated and the factors influencing generation and the availability and magnitude of wind resource.
- To present the different types, scales and classification of wind turbine generators (WTG), discuss their suitability for different applications, their siting and health and safety requirements and relative advantages / disadvantages.
- To highlight to learners how to assess sites for suitability for wind turbines and assess their energy, carbon and cost impact potential.
- To introduce key design, installation, operation and maintenance considerations of the various WTG system types.

Contents

The session includes the following:

Introduction to the technology / overview of common system types:

The sessions starts by highlighting that wind driven renewable electricity generation is ultimately driven by solar power. The session continues by introducing the main types of built environment related wind turbine generator systems, and their applications. This includes grid connected systems (electrical supply applications), stand-alone direct connect system (e.g. historically for heating or pumping applications), or stand-alone battery systems (for electrical supply applications).

System classifications

The series of International standards focused on technical aspects of WTG performance and certification is introduced, EN 61400. It is highlighted that the standard has been under revision since October 2014. In addition, the following parts are specifically highlighted:

- BS EN 61400-1:2005+A1:2010 – *Wind turbines - Design requirements*

Attendees are advised that Part 1 provides standard for many aspects of the WTG lifecycle, that it applies to all sizes of WTG, and that it specifies minimum design requirements, including: Structural integrity; Control and protective functions; Measures to ensure the safety of people; Criteria for reliable operation and survival of the WTG, with respect to the operating conditions for a particular class of site; Basic design requirements for safe operation, inspection and maintenance.

In addition, the material also highlights that “EN 61400-2:2014 - *Wind turbines. Design requirements for small wind turbines*” applies specifically to “small” WTGs, and that these are defined as having a swept area of < 200m2 (equivalent to a rotor diameter < 16m, or a maximum rating of ~ 50kW). This is the scale of WTG that are most likely going to be of relevance to nZEB. The session highlights that the part 2 standard covers safety, quality assurance and engineering integrity, through design, testing, installation and operation of small WTGs. The session introduced the UK Government’s “microgeneration certification scheme” and also highlighted that the Renewable UK (UK wind trade body) define micro wind as WTG

under 3.5kW (equivalent to a rotor diameter ~ 4m) which typically includes building mounted wind turbine, which may be of relevance to nZEBs.

System components

The key components (tower, foundation, nacelle, rotor blades, tail, etc) and definitions (hub height, rotor diameter, swept area, etc.) of a wind turbine system is presented (using a tower mounted, horizontal axis turbine as an example) so attendees can assimilate themselves with key wind turbine terminology.

Resource

An annual average wind speed map of European is presented to show the variability in wind resource across Europe. The map and supporting data is used to also explain the importance of hub height on wind speed. General, minimum, small scale WTG wind speed requirements are listed and discussed. The attendees are made aware that additional, higher resolution, wind speed data is typically available and whilst this is explained in the local country; the UK Government Department of Energy and Climate Change, NOABL wind speed database (http://tools.decc.gov.uk/en/windspeed/default.aspx) (which provides average wind speeds for a 1 km grid square upon presenting a post/zip-code) is used to demonstrate an example.

Design, installation, operation and maintenance:

Key design considerations are then presented including:

- Siting considerations: general good practice requirements concerning minimum distances to significant nearby obstructions is presented, as well as guidance from the UK MCS scheme concerning the extent of upstream and downstream obstruction zones, and the likely impact (reduction) on energy performance from small scale WTGs due to obstructions within these zones.
- Shadow flicker is introduced and (current UK-based) guidance is presented on shadow flicker zones (relative to the turbine location) as general information.
- Grid connection / Balance of plant: the various balance of plant systems for grid connected WTGs is presented and discussed complete with photographs and schematic diagrams.
- Structural design / mounting requirements – identified as a key safety related design issue.
- Other issues e.g. planning requirements, acoustic restrictions, importance of effective operation and maintenance to ensure longevity and long term safety of operation.

Energy Performance:

The equation governing power generation from WTGs is presented (Power = ½ x ρ_{air} x A x v^3 (W or kW)) and discussed, including most importantly that power varies as radius squared, and that power varies as velocity cubed. This is re-enforced so that attendees understand the impact of key variable that influence wind turbine energy generation potential. The session also introduces the concept of Betz law (a principle that not all of the energy can be captured from the wind, but rather a theoretical maximum of #60% (Betz limit) is available. The concept of coefficient of performance is then introduced and attendees advised that real-world capture is likely to be of the order of 30 – 40% of the total power in the wind.

Further information:

Further sources of information on WTG systems is then presented including the European Wind Energy Association (EWEA), as well as other, country specific, wind turbine guidance standards or documents, trade bodies, associations and agencies. Sources of additional information and publications on micro and building mounted wind turbines is also presented.

Exercises:

The presentation material is supplemented with a small number of questions and a practical exercise (including calculations) for attendees to apply their new learning on wind turbine energy performance related issues and discuss key issues affecting WTG feasibility.

Learning outcomes

The outcomes from Session 2 will be as follows:

- Knowledge regarding the different types of small (< 50kW) wind turbine generator (WTG) systems and awareness of the key factors influencing generation potential and thus turbine suitability for supplying energy to building.
- Knowledge regarding the different types, scales and classification of WTGs and awareness of their suitability for different applications, siting and health and safety requirements and relative advantages / disadvantages.
- Knowledge as to how to assess sites for suitability for WTGs and assess their energy, carbon and cost impact potential.
- Awareness of key design, installation, operation and maintenance considerations of WTGs

4.4 Session 4: Solar Thermal

Learning objectives

- To introduce attendees to the concept of renewable energy generation via solar thermal (STh) systems and to understand how collectors capture, and transfer energy to building energy systems. Introduce the availability and magnitude of solar resource and understand the factors affecting energy capture and use in buildings.
- To present the different types of STh panel, discuss their relative merits and present common STh designs and configurations.
- To introduce means of calculating the energy performance / potential of STh systems and thus assess their energy, carbon and cost impact.
- To introduce key design, installation, operation and maintenance considerations.

Contents

The session includes the following:

Introduction to the technology / system components

The sessions starts by providing an introduction to Solar Thermal technology explaining that collectors are used to absorb solar radiation with the energy being typically used to heat water. Available solar resource is introduced as well the key system components that typically make up a solar thermal systems (collector, hot water cylinder, pump, values, controller, auxiliary heat source, etc.). The importance of collector orientation and inclination is introduced.

The two different types of collector are introduced (flat plate collector and evacuated tube collector) and each is discussed in more detail so attendees understand the differences between the two components in terms of their design, operation, efficiency and cost, so attendees can assimilate themselves with key wind turbine terminology and factors influencing their feasibility.

Overview of common domestic hot water system types

The concept of primary and secondary systems is introduced, and attendees are also introduced to the concepts of different domestic hot water system design types (including vented, unvented/pressurised) and various hot water storage options (e.g. twin coil cylinders, pre-heat cylinders, direct heater input) in relation to their integration with solar thermal systems.

Design, installation, operation and maintenance:

More detailed guidance is then presented on common indirect domestic hot water systems with twin (solar) coil cylinder. This guidance includes highlighting the need for effective differential temperature control on the solar system to ensure it operates efficiently. Key safety related issues concerning solar thermal systems design, and in particular pressurised domestic hot water systems, is highlighted.

Key design considerations are then presented including:

- Solar volume – the material introduces the concept of dedicated solar volume and its importance is presented.
- Temperature control – including the fact that systems will exceed 60 degrees centigrade, that they can stagnate and that there must therefore be suitable system protection. Also that other system components need to be suitably rated for the high temperatures and pressures that they system may present.
- The concept of different temperature control operation to enable automatic transfer of energy when system conditions are correct.
- Temperature protection against growth of legionella bacteria where systems do not regularly reach 60 degrees centigrade.
- System sizing consideration including reference to UK Chartered institute of Building Services Engineers domestic hot water consumption guidelines.
- Collector mounting issues and consideration including planning, durability and need for structural assessment.]
- Installation issues including need for high temperature insulation, suitable temperature rating on pipework, supports, jointing methods, etc.; presence of safety devices, etc.
- Operation and maintenance consideration including typical checks to perform.

Energy Performance:

The International Energy Agency means of estimating the performance of a solar thermal system is then introduced. The variables in the equation are discussed in order to enable attendees to understand the variables and how these may impact on total annual energy generation, as well as understand what information they need to identify / collect / obtain in order to facilitate an assessment. Attendees are also advised that the equation based method is only an approximate method and that more detailed calculation methods are available. A worked example of the calculation is presented. A cost appraisal example is also provided in order to provide attendees with an example process that they can use to assess the cost effectiveness of a solar thermal system, including a simple payback calculation.

Resource

The EU Joint Research Council PVGIS tool (http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php) is presented as a robust means of obtaining solar radiation data to input to the IEA energy generation estimation equation.

Further information:

Further sources of information on photovoltaic systems is then highlighted including the global solar council, the International Energy Agency Solar Heating and Cooling (IEASHC) Programme, the European Solar Thermal Industry Federation (ESTIF).

Exercises:

The presentation material is supplemented with a practical exercise for attendees to apply their new learning, whereby attendees need to carry out calculations to estimate energy generation, and carry out an appraisal of energy, cost and carbon savings for offsetting various fuels, as well as a payback calculations. An additional exercise is presented to enable attendees to consider and discuss key issues affecting solar thermal feasibility.

Learning outcomes

The outcomes from Session 4 will be as follows:

- Knowledge on how STh systems operate and the types of systems available, including awareness of advantages / disadvantages of the various system types and designs.
- Knowledge and awareness of available solar resource and the local and global potential available for energy capture including awareness of basic energy performance calculation methods and available resource maps, design and assessment tools to assist in assessing STh feasibility, as well as system energy, carbon and cost impact.
- Gain knowledge in respect of the key design, installation, operation and maintenance considerations, thereby enabling learners to apply this knowledge appropriately in their profession.

4.5 Session 5: Energy Storage

Learning objectives

- To introduce attendees to the important role than energy storage has to play in supply/demand matching, and in particular where renewable energy is generated on site, such as in the case of nZEBs.
- To provide a high level overview of various solutions and associated techniques, to address supply/demand matching issues and to introduce the main types of electrical batteries, and discuss key issues affecting battery performance, safety and use, and introduce key factor affecting battery technology selection.
- To introduce common battery storage solutions for buildings and discuss design and operation considerations, including consideration of non-fossil fuelled storage mediums (i.e. phase change materials) and other forms of energy storage e.g. power diverters.
- To introduce ground source heat pumps (and the concept of low grade heat / coolth being available in the ground) and the potential for cooling applications and/or seasonal energy storage.

Contents

The session addresses the following:

Challenges

This session sets out the main energy system challenges and highlights how energy storage can help provide a solution to these issues. The challenges discussed include; peaks and troughs in demand, peak demand, grid resilience and security, variability of renewable energy sources (and their relative unpredictability). Some examples are used to illustrate the potential that energy storage technology has to play (e.g. the difference between a typical non-domestic electricity demand profile and the availability of solar resource (in a northern hemisphere location); and an example of the fluctuating short term variability in national electricity demand over an 8 hour period).

Some solutions

A number of potential solutions to the above issues are introduced briefly. The potential solutions cited include: demand side management, international interconnectivity, grid and/or building level energy storage. It is explained that energy storage technology can offer potential to assist with peak load shaving, load shifting and voltage and frequency stabilisation.

Types of storage

A range of non-fossil fuel based storage systems are the listed for information / completeness, including: chemical solutions (batteries, hydrogen), electromagnetic / electrostatic, heat storage methods (ground, water, heat engines), mechanical based storage (pumped water, flywheels, compressed air).

The session focusses on battery based storage technology in the context of buildings.

Main battery technologies

A comparison of the main battery types is then presented. This includes information on the advantages and disadvantages of the various types, their relative maturity and main applications.

How batteries behave (especially Li-ion)

In this part of the session information is presented in relation to the nature of charge / discharge cycle losses of batteries; impact on cycle lifetime as a results of depth of battery discharge per cycle, and thermal stress impacts.

Factors for technology selection

In this part of the session it is highlighted to attendees that understanding the above factors is essential to for correct design of battery systems, and that the key characteristics affecting appropriate matching of battery technology to an application include consideration of: power, capacity, energy density, cycled life, self-discharge rate, reliability, safety considerations, etc. the disadvantages of battery are also discussed (including potentially hazardous, unsustainable, limited life, wasteful due to inefficiencies).

Examples:

A number of brief examples are then presented to demonstrate the possibilities for battery storage applications in building design. Examples include:

- Standalone PV system with DC battery storage
- Grid connected storage systems (DC coupled or AC coupled storage (and a comparison between both)). Additional information is presented on emerging products such as storage enabled inverters, or inverters packaged with charge controller and battery storage.

Cost effective options for non-electrical storage is also introduced (including power diverters where excess generation can be diverted in to hot water cylinders, underfloor heating, towel rails, phase change material, etc.). Making use of energy storage in electric vehicles (vehicles to building, V2B) is also briefly mentioned as a potential future energy storage application.

Ground source heat pumps

Low grade energy stored in the ground is also discussed and the concept of ground source heat pumps / cooling is introduced. Details are presented of the typical difference between air temperature, and ground temperatures at various depths, and that this also offers the potential for cooling, as well as heating, of buildings. The concept of coefficient of performance of heat pumps / refrigeration cycles is introduced. Issues concerning high installation costs are discussed, however climates requiring both heating and cooling over the course of a year are highlighted as being more promising because they generate benefits during both winter and summer.

Learning outcomes

The outcomes from Session 5 will be as follows:

- Knowledge and awareness of the role that energy storage can play in helping achieve nZEB and awareness of various (building level) energy storage solutions including battery, phase change and diverting technologies.
- Awareness of the main types of electrical batteries and knowledge of the key issues affecting battery design, selection and performance.

4.6 Session 6: Cost Optimal

Learning objectives

- To introduce attendees to the long-term decarbonisation goals of the EU.
- To highlight that key requirements of the recast Energy Performance of Buildings Directive (EPBD, 2010/31/EU) in relation to new building design.
- Introduce the concepts of cost-effectiveness and cost-optimality.
- Introduce the global cost calculation method: EN15459:2007 - Energy performance of buildings — Economic evaluation procedure for energy systems in buildings; and its key concepts and methodology.

Contents

The session addresses the following:

Context and Background

This session starts by highlighting to attendees the long-term decarbonisation goals of the EU and the *EU Roadmap for moving to a competitive low carbon economy in 2050* (COM, 2011a) which identifies potential CO_2 emissions reduction of 88% to 91% by 2050 compared to 1990 levels (for the residential and services sectors). The role that better construction and use of buildings can play – if lifetime costs are considered rather than simply initial capital cost – is also highlighted.

EPBD Recast

The recast Energy Performance of Buildings Directive (EPBD, 2010/31/EU) is then discussed, including the requirement for European Member States to:

- introduce minimum energy performance requirements for buildings, building elements and technical building systems; and to
- set these that requirements based on a cost-optimal methodology that takes into account the lifetime costs of the building (i.e. investment, operational, maintenance, disposal and energy saving costs of buildings).
- Construct only nearly Zero-Energy Buildings from 2020 onwards.

The presentation highlights the *Commission Cost-Optimality Delegated Regulation* and highlights that guidance to member states provides a very large degree of flexibility when selecting the input data for the calculation as well as the selection of reference buildings.

Attendees are introduced to the following (European Commission) definition of the “cost-optimal level”:

“the energy performance level which leads to the lowest cost during the estimated economic lifecycle.” *“MS will determine this level by taking into account a range of costs including investments, maintenance, operating costs and energy savings.”*

In addition, it is highlighted that the EPBD requires members states to report on the comparison between their minimum energy performance requirements and the calculated cost-optimal levels, and explains what this comparison must consider.

Cost Effectiveness & Cost Optimality

THE sessions continues by then introducing and explaining the (related, but different) concepts of cost-effectiveness and cost-optimality (and both the macroeconomic and microeconomic perspectives). A simplified overview of the process for implementing a cost optimality assessment is also presented.

In addition, key future impacts that cost optimality will have on the construction industry are highlighted including the financial gap, energy performance gap and environmental gap between cost-optimal levels and nZEB (2020) performance requirements.

EN15459:2007 - Economic evaluation procedure for energy systems in buildings

The global cost calculation method is introduced and it is highlighted that the evaluation method can be used, in full or in part, for the following purposes:

- to consider the economic feasibility of energy conservation options in buildings;
- to compare different solutions of energy saving options in buildings
- to evaluate the economic performance of an overall design of the building

- to assess the effect of possible energy conservation measures on an existing heating system, by economic calculation of the cost of the energy use with and without the energy conservation measure.

The sessions continues by advising attendees of the scope of the standard (i.e. buildings and its systems) and discussing acceptable calculation durations (i.e. building lifetimes 10 – 25/30 years) as well as an overview of the content of the standard and the assessment methodology. A number of schematics and flowcharts are used to support the leaning (e.g. a schematic from EN15459 showing the organisations of costs (investment and running) relating to the various building elements and energy systems. The reporting concepts of “final value” and “annual cost” are also introduced.

Exercise:

The presentation material is supplemented with a practical exercise where attendees apply a whole life appraisal to a photovoltaic system in order to familiarise themselves with the concept of whole life costs appraisal. Attendees are also advised that detailed worked examples (undertaken in accordance with EN15459 are available within the EN 15459 standard).

Learning outcomes

The outcomes from Session 6 will be as follows:

- Knowledge of the magnitude of the opportunity for carbon savings that can be realised by considering lifetime costs (i.e. construction, operation, maintenance and disposal) of buildings rather than simply initial capital cost of construction.
- Understand the difference between cost-effectiveness and cost-optimality and understand the impacts of cost-optimality on future building design.
- Gain knowledge and awareness of the global cost calculation method (EN15459:2007) and its key concepts and calculation methodology.

4.7 Session 7: Building Control and Automation

Learning objectives

- To introduce attendees to the need to manage energy consumption in nZEBs via the effective control of building energy systems. Furthermore, to introduce key control concepts / options for common building energy loads.
- To introduce the classification of control system as defined within EN 15232:2012 - Energy performance of buildings – Impact of Building Automation, Controls and Building Management.

Contents

The session addresses the following:

Introduction to the need for controls:

This session starts by highlighting the reasons why we need to manage energy. A number of business drivers are highlighted such as rising energy costs, green credentials, security of supply, legislative drivers, etc. It is also highlighted that lifetime energy consumption in buildings is significant (energy can account for about 40% of the running cost of a building over its lifetime) and so it is explained that controls are needed to manage the effective use of energy and that this is especially important in the context of nZEBs. Building

energy controls are then introduced as being (stand-alone units or full building control and management) systems designed to provide a comfortable climate for building occupants while ensuring the lowest energy consumption, and that they can manage a wide range of building energy systems (examples are provided).

The session continues by discussing reasons as to why should we use building controls (good control is essential to optimise levels of service, comfort and safety in an energy efficient manner) and a number of benefits of well designed and installed controls are listed and explained.

BS EN 15232:2012 Energy performance of buildings – Impact of Building Automation, Controls and Building Management

THE above standard is introduced and explained as providing a means of classifying different complexities of building control systems (i.e. class A = high energy performance system, through to Class D = non energy efficiency system). Definitions of building automatin and control systems (BACS) and technical building management systems (TBM) are explained. A simplified example is then used to demonstrate the classification systems within EN 15232.

Controls within Building Regulations (new build)

Minimum control requirements, within the context of local building regulations, is then discussed. It is highlighted that Regulations typically stipulate a basic functionality required to operate a new building but not necessarily in the most efficient manner. The effective design of nZEBs must go significantly beyond minimum regulatory requirements.

Control basics / types of control

Attendees are introduced to the basic principles of control theory e.g. the concept of sensors, actuator/controlled device and a controller. The concept of open-loop or closed loop (feedback) control is also introduced and the efficiency benefits of closed loop is explained. Various types of controls are then discussed (e.g. on/off, proportional, PID) along with the importance of having effective control “settings” in order to ensure acceptance performance in terms of comfort and energy efficiency.

Common (individual / stand-alone) building energy system control types and functions are then introduced and explained, with examples, including: Optimum start/stop; Sequencing; Weather compensation; Demand control or zone control; Boiler load optimisation; Occupancy controls; Variable controls; and Interlock controls

Technical building management systems (TBMs) / Building automation and control system (BACS)

Integrated / multi-control systems are then introduced including the difference between TBMs and BACS control systems. It is explained to attendees that TBMs control and monitor plant such as lighting and HVAC in order to specifically address energy use, however they do not integrate all parts of the building as a BACS does i.e. a BACSC can control plant as well as other system such as security, fire protection, etc. Key issues relating to TBMs and BACS design are introduced and discussed, including: higher costs but added value benefits from system, need to engage with occupants at design stage and have a coordinated design, the importance of effective installation and commissioning, operation and training of operatives, ongoing maintenance.

Summary of Important considerations

The session concludes by summarising a number of important considerations when evaluating, designing or implementing control systems including the need to: Understand occupancy patterns, schedules and

density and servicing strategy; Undertake “value engineering” to inform specification; evaluate effectiveness of any additional functionality; aim to future proof the design; consider links to Monitoring and Targeting systems; enable management reporting; undertake effective commissioning, training and maintenance.

Learning outcomes

The outcomes from Session 7 will be as follows:

- Knowledge concerning the need to manage energy consumption in nZEBs via the effective control of building energy systems.
- Awareness of key control concepts / options for common building energy loads. Learners will be able to apply awareness of building automation systems within their own work, enabling them to consider the delivery of satisfactory internal environments for occupants with the importance of effectively manging energy use within nZEBs.
- Awareness of different classifications and complexities of control system (including technical building management systems (TBMs) and Building Automation and Control System (BACS)) aligned to the EN 15232:2012 - Energy performance of buildings – Impact of Building Automation, Controls and Building Management, standard.

5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risk.

Risk - description	Risk Level	Risk management action
Lack of delivery of training materials by partners and complexity of developing material suitable for each country).	High	BRE and the local country partner to combine material supplied in each country with master material to create four “local” versions of the course. Hold session on training courses at next partners meeting to resolve any issues; hold special tcfs for WP3 as required. Coordinator action as required.
Poor delivery of classroom training by target country partners and trainers	Medium	BRE can coach the partners in the target countries and the trainers through Q&A sessions by video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low - Medium	BRE and the local country partner will monitor rates and amend course content to support areas where there are specific issues.
Excessive differences in local issues	Low	BRE will review local material and advise on changes as required.

6. COMMENTS BY EXTERNAL REVIEWER

ITEM	REVIEW	ACTION
Training Module	Module 7 – low carbon technologies and automation.	
Does the subject matter match the description – explain reasons	There is evidence of a good match with the module brief and learning objectives: the main (but not all) low carbon technologies are covered, a cost comparison method is described, and the role of building monitoring and automation is elaborated. That said, many of the slides offer only bullet points with no detail on the concepts and procedures to be imparted; I assume that these are a work in progress.	Further detail added to slides for completion
Would you recommend this training course for use in SZEB – explain reasons	Yes, after final refinement and the inclusion of missing materials as described below.	Completed
General quality assessment – please comment	Good introductory material but with a tendency toward optimistic performance returns. The module would benefit from the inclusion of cautionary statements relating to the changing fiscal landscape and the failure of many systems to deliver in practice because they were inappropriately designed in the first place.	Amendments completed
Further comments	-	
Suggested actions for this module	Add material to complete the picture and suggest a design approach that can accommodate the complexity of an effective nZEB design (new material could either be placed here or included by linkage to other modules).	
Please add comments on specific sections and slides here.	7-1_intro: The importance of passive solar measures is emphasised but nowhere explained. Some low carbon technologies are also mentioned (e.g. heat pumps and biomass boilers) but not addressed thereafter. 7-2_photovoltaics: Mostly OK but comes across as a sales job for PV in the absence of any coverage of the problems encountered in practice and the fact that subsidy is driving sales. 7-3_small scale wind: Should include material on the negative aspects of wind turbines (failure to deliver at the small scale, poor demand match, non-trivial sizing requirement *etc*.). 7-4_solar thermal:	Further changes made to material to address comments

	Is this the place to put air source heat pumps? 7-5_storage: Mostly focuses on battery storage, what about heat storage such as enabled by the quantum heaters of the SSE NINES project or delivered by rechargeable PCM thermal stores? 7-6_cost optimal: Successfully introduces the underlying concepts of EN15459 but should also clarify the calculation method and give practical advice for its use in practice. 7-7_building controls: Good basic coverage but emerging issues such as demand management, demand response and active network control are missing.	

APPENDIX H - DESCRIPTION OF MODULE 8: RETROFITTING

2 WP3 – TASK 2 - TRAINING MODULE 8 – RETROFITTING TOWARDS NZEB DESCRIPTION

2.1 Preparation and delivery

Preparation of the course material is undertaken by University of Minho (UMinho) with the collaboration of the University of Patras (UPatras) and the Cyprus University of Technology (CUT) (in accordance with the Description of Work). UPatras prepares Session 1, Session 2 and Session 7; UMinho prepares Session 3, Session 5, Session 6 and Session 8; CUT prepares Session 4. The Exams are prepared by KEK.

The individual responsible is Dr. Manuela Almeida an Associate Professor of UMinho. Dr. Manuela Almeida has been undertaking thermal performance of buildings, rational use of energy in buildings, building conservation and rehabilitation and energy modelling for more than twenty-five years of activity at the University of Minho and coordinates/participates in several international or national research projects in the area of energy efficiency and energy renovation of buildings. She is assisted as required by Dr. Sandra Silva and Dr. Luís Bragança of UMinho Sustainable Construction Group. Dr. Manuela Almeida is also responsible for the quality check of the material produced.

Local issues are determined and course materials prepared by the partners in the target countries. This content does not exceed 15% of the course. The contents section sets out the local issues that were prepared by the target country partners.

Delivery of the training course material to trainers is undertaken in each country by the relevant partners (in accordance with the Description of Work); in Cyprus by CUT, in Greece by KEK (Euro Training), in Italy by DTTN and in Portugal by UMinho and IST-ID. After, the trainers deliver the courses to the trainees.

2.2 Outline of Module 8 – Retrofitting Towards nZEB

Module 8 aims at presenting to engineers, architects, building supervisors, site managers, building auditors, government and local authorities involved in the regulation of energy efficient buildings, the way to retrofit the existing building stock towards nZEB considering both energy efficiency and indoor environmental quality.

This module focuses on how to address the existing building stock and the possibility of its conversion into nZEB. Assessment and energy audit techniques in existing buildings are also part of the training goals as well as the cost optimality of nZEB renovation technical solutions.

Module 8 includes sessions on applicable directives, regulations and standards; the concept and definition of nZEB; nZEB strategies; existing and emergent renovation solutions; integration of renewable energy sources in existing buildings and/or neighbourhoods; renovation solutions towards nZEB; cost optimality for nZEB; methodology to asses cost optimal renovation solutions; cost optimal renovation packages; the users' expectations and users' acceptance of renovation measures; co-benefits associated to renovation measures; drivers and barriers associated to renovation works; available tools to support cost-effective renovation works; energy audits; best practices and case-studies.

The estimated duration of the training is 40 hours, divided in pre-course preparation, classroom, post-course study and exam.

This training module is coordinated, designed and planned by UMinho, with the collaboration of UPatras and CUT, but also partners from each country (Cyprus, Greece, Italy and Portugal) developed the specific training material related to their own countries. As a result, the approach changes between countries in order to allow for local regulations and traditions to be fully explained.

2.3 Purpose of the training

The reduction of carbon emissions and energy use are important goals for the European Union due to the Europe's energy dependency, increase of energy costs and climate change mitigation. Being the building sector responsible for 40% of the energy consumption and 32% of the greenhouse gas emissions in Europe, buildings are an important target for the reductions of energy use and greenhouse gas emissions. Therefore, improving the buildings energy performance is an important part of the EU 2020 and 2030 energy targets as well as of the roadmap for moving towards a competitive low carbon economy in 2050. However, to achieve the settled targets it is mandatory to improve the performance of the existing building stock due to its large dimension and poor energy performance as well as due to the small rate of construction of new buildings all around Europe turning the action only on these new buildings insufficient. Renovation towards nZEB is now a goal of the European countries also ensuring that buildings are cost-effective during their life cycle. The renovation of existing buildings is an opportunity to improve their energy performance that is frequently missed. This happens due to the higher initial costs but also due to the lack of know-how and awareness (from owners, tenants and stakeholders) regarding the cost effectiveness of the energy renovation measures, especially if a life cycle cost approach is considered.

To achieve a nZEB performance level it is necessary to reduce the energy needs of buildings through passive approaches (improving insulation levels, optimizing solar gains, use external shading systems and night cooling, etc.), selection of efficient appliances and systems (lighting, appliances, heating, cooling and ventilation systems) and on-site production of renewable energy in order to reduce the remaining (very low energy needs) non-renewable energy use. Solar thermal and photovoltaic systems and geothermal and biomass energy sources are the most common energy sources used in buildings. However, for an effective renovation of the building stock, a life cycle cost approach is needed where the cost optimal renovation solutions must be identified. Thus, it is essential that technicians, stakeholders and building owners are aware of the challenges of renovating towards nZEB and which are the most adequate techniques and renovation solutions.

The purpose of the training is to inform professionals and other stakeholders on the need to retrofitting the building stock for near zero energy buildings. It addresses the regulation and standards related to nZEB and retrofit, building traditions and local context in the target countries.

The training addresses how nZEB can be achieved during retrofit works, the nZEB renovation strategies and solutions (passive and active) and the integration of renewables is also covered. The cost optimal methodology and life cycle cost assessment applied to the renovation of buildings, users' expectations and users' acceptance of renovation measures, the co-benefits of a renovation process and drivers and barriers associated to renovation works are presented to show the added value of retrofitting towards nZEB.

The tools to support cost-effective renovation works towards nZEB, the objectives, strategies and techniques, the methodology followed and equipment used in energy audits are also studied.

The aspects that will be covered in this training module are as follows:

- Definition of the nZEB concept in building retrofit;
- European Directives, building regulations and national and international standards related to building retrofit;
- Building traditions, local context and local impact / issues;
- nZEB renovation strategies;
- Passive and active renovation solutions towards nZEB;

- Integration of renewable energy systems;
- Cost optimal methodology applied to the renovation of buildings;
- Life cycle costs assessment;
- Cost optimal renovation solutions according to the local context;
- Users' expectations and users' acceptance of renovation measures;
- Co-benefits associated to a renovation process;
- Drivers and barriers associated to renovation works;
- Tools to support cost-effective renovation works towards nZEB;
- Energy audits. Objectives, strategies and techniques; methodology followed in energy audits; equipment used;
- nZEB best practices in renovation works.

2.4 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience (course, webinar, self-study or group activity). Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experiences.

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials.

Learning objectives:

- Provide clarity about the purpose of the course;
- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals;
- Establish accountability between the learner and the instructor;
- Help trainers articulate exactly what they want participants to do by the end of the training.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound.

The learning (specific) objectives of Module 8 are as follows:

- To understand the concept of nZEB, its importance to achieve the EU targets and its relevance to the related stakeholders;
- To understand the concept of nZEB in the context of building renovation and its relationship with the EU goals and requirements of the European Directives and national building regulations to achieve nZEB levels;
- To identify nZEB renovation strategies;
- To understand and to apply the cost optimal methodology to the renovation of buildings;
- To identify cost optimal renovation solutions towards nZEB;
- To understand the difference between cost optimal solutions and net zero energy solutions;
- To understand and identify the users' expectations and users' acceptance of renovation measures as well as the co-benefits associated to a renovation process;
- To understand the drivers and barriers associated to renovation works;

- To identify and use available tools to support cost-effective renovation works towards nZEB;
- To understand, identify and apply the strategies to perform energy audits;
- To identify nZEB best practices in renovation works.

Measurable – learners, after completing the course, are able to define and implement cost optimal renovation strategies and solutions to existing buildings considering their life cycle. Learners will be able to understand and explain to others the drivers and barriers associated to renovation works and the users' expectations and users' acceptance of renovation measures as well as the co-benefits associated to a renovation process. Learners will also be able to perform energy audits and use simulation tools to support cost-effective renovation works towards nZEB.

Action – learners will be able to address the implementation of nZEB retrofit within their own work, taking into consideration life cycle costs, cost optimal solutions, users' expectations and users' acceptance, addressing the drivers and barriers associated to renovation works. Learners will also be able to perform energy audits and use simulation tools to support cost-effective renovation strategies. They will also be able to explain to clients, colleagues and other stakeholders the issues involved in retrofitting towards nZEB.

Reasonable – PowerPoint slides are supported by reading documents recommended to be studied before and after attending the course and additional material is presented as bibliography in each section; the learning required is commensurate with the objective.

Time-bound – learning will be completed after the training and completion of course reading.

2.5 Learning audience – trainers and trainees – qualifications and experience

The trainers and trainees are those building professionals involved in the design, construction and renovation of buildings, as well as those involved in the building regulation system. Professions will include engineers, architects, building supervisors, site managers and building auditors. Government and local authorities' officials involved in the regulation of energy efficient and nearly zero energy buildings will also be included.

The trainers should be members of a relevant construction profession and have extensive experience in practice of the design and construction of buildings, preferably of energy efficient buildings, at least five years' experience in practice of the design, construction and renovation of nearly zero energy buildings. Experience of supervision of staff and previous experience in delivering training are also taken into account.

The trainees include the building professionals described above, but with any number of years of experience from graduation through to senior company directors.

3 STRUCTURE OF MODULE 8

The estimated duration of the training is 40 hours. The structure of the training course is as follows:

- Preparation – involving an on-line introduction and background reading; the approximate duration is 6 hours.
- Class based training – involving delivery by a trainer of the main components of the training. The delivery will be given by the approved trainer to between 20 and 30 trainees at each session. The approximate duration of the classroom training will be 20 hours.
- Post classroom based training, self-learning and exam preparation. The training will include on-line consultation of the contents of the e-learning platform and self-assessment. The approximate duration of this part of the training will be 11 hours. Attendees will also need to dedicate approximately 2 hours to prepare for the competency assessment. The duration of the post classroom training, self-learning and exam preparation is therefore approximately 13 hours.
- Competence assessment – this will be delivered through a one hour written exam that will involve a multiple-choice exam. The assessment will take 1 hour to complete.

3.1 Time Allocation of M8 – Retrofitting Towards nZEB

It is foreseen to have 20 hours of classroom training, distributed per section as follows:

- Session 1 – Definition of the nZEB concept (1.0h);
- Session 2 – Building regulations and standards and local construction traditions (2.0h);
- Session 3 – Strategies, technics, solutions and materials towards nZEB (4.0h);
- Session 4 – Cost optimal renovation solutions (2.0h);
- Session 5 – User's acceptance and user's expectation of the renovation measures, drivers, barriers and co benefits related to renovation process (2.0h);
- Session 6 – Tools to support cost-effective renovation works towards nZEB (3.0h);
- Session 7 – Practical session (3.0h);
- Session 8 – Case study (3.0h);
- Exam (1.0h).

3.2 Course reading material

A number of documents are indicated as necessary (pre-course and post-course) and additional reading material related to energy efficiency of buildings and building renovation is pointed out. The material prepared by UMinho will include a PowerPoint presentation covering the following:

- European Directives and National Legislation;
- National and international related standards (EN, ISO, etc.);
- Concept of nZEB renovation;
- Design framework for achieving nZEB in existing buildings;
- Criteria to track nZEB building renovation;
- nZEB renovation strategies
- Examples of highly efficient renovated buildings;
- Case-studies in partner countries.

Pre-classroom

Pre-classroom study will include energy efficiency issues, nZEB related scientific papers, the Energy Performance of Buildings Directive, the recast of the Energy Performance of Buildings Directive, national building regulations/standards relevant to energy performance of buildings, Commission Delegated Regulation (EU) No 244/2012.

Training Module 8 pre-classroom recommended bibliography:

European Commission (2002). Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings (EPBD).

European Parliament and the Council of the EU (2009a): Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC (RED 2009)

European Parliament and the Council of the EU (2009b): Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC

European Council for an Energy Efficient Economy - ECEEE (2009): Net zero energy buildings: definitions, issues and experience. Published by ECEEE, Brussels

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European Commission - IP/14/54 22/01/2014 (2014) 2030 Climate and Energy Goals for a Competitive, Secure and Low-carbon EU Economy.

European Commission (2014) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - A policy framework for climate and energy in the period from 2020 to 2030. Brussels, 22/1/2014 (available at: http://ec.europa.eu/clima/policies/2030/documentation_en.htm).

EN 15242:2007 - Ventilation for buildings. Calculation methods for the determination of air flow rates in buildings including infiltration

EN 15450:2007 - Heating systems in buildings. Design of heat pump heating systems.

CR 1752 - Ventilation for buildings – Design criteria for the indoor environment

BPIE, (2011), Europe's Buildings under the Microscope. (http://www.europeanclimate.org/documents/LR_%20CbC_study.pdf)

BPIE (2013). Implementing the Cost-Optimal Methodology in EU Countries – Lessons learned from three case studies ISBN: 9789491143083

BPIE, 2013. A Guide to Developing Strategies for Building Energy Renovation - Delivering the Energy Efficiency Directive Article 4 requirements on long term strategies for mobilising investment in renovation of national building stocks

BPIE, (May 2014), Alleviating Fuel Poverty in the EU Investing in Home Renovation, a Sustainable and Inclusive Solution (http://bpie.eu/uploads/lib/document/attachment/60/BPIE_Fuel_Poverty_May2014.pdf)

BPIE (2016). 2016 – Implementing the Energy Performance of Buildings Directive (EPBD). (http://www.epbd-ca.eu/ca-outcomes/2011-2015)

IEA, (2013), Transition to Sustainable Buildings Strategies and Opportunities to 2050, http://www.iea.org/publications/freepublications/publication/Building2013_free.pdf

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Post classroom

Post-classroom study will include deepening the analysis of the documents listed for the pre-classroom study and the detailed study of the conventions for nZEB calculations (standards, national regulations, Commission Delegated Regulation (EU) No 244/2012). The post classroom study includes the following:

- Standards;
- Tools;
- Techniques;
- Best practice examples.

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Websites with important information:

http://www.bpie.eu/eu_buildings_under_microscope.html#.VUEBepPiog4

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http://iet.jrc.ec.europa.eu/energyefficiency/system/tdf/eur26888_buildingreport_online.pdf?file=1&type=node&id=9069

http://www.buildup.eu/publications/38183

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National building regulations/ standards relevant to energy performance of buildings and thermal comfort:

Cyprus

Laws

N142(I)/2006 – On the Regulation of the Energy Performance of Buildings Law 2006

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Decree Laws & Regulations

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KDP 366/2013 – On the Regulation of the Energy Performance of Buildings (Requirements and Specifications to be met by the near Zero Energy Building - nZEB) Decree 2014

Greece

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Portugal

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4 CONTENT OF MODULE 8

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content is split into eight sessions that will be run over the entire training seminar duration. Each session is introduced by the trainer and the connection with the learning objectives and outcomes explained. The sessions vary in timing and content. The course material is delivered through PowerPoint slides, which are made available, in the national languages, to the trainees. The trainers have additional notes available to them on the PowerPoint slides. Additionally, there is a practical session with simulation tools and analysis of a case study and a session of good practices examples of building retrofitted towards nZEB.

The sessions are described in this section, including relevance to the objectives and the learning outcomes. The eight sessions are as follows:

- Session 1 (1.0h) – prepared by UPatras
  - Definition of the nZEB concept
  - Global context
  - Social and political understanding of the issue
  - The nZEB concept in building renovation
- Session 2 (2.0h) – prepared by UPatras
  - European Directives, building regulations and national and international standards related to the topic (collaboration is needed from target countries)
  - Building traditions and local context (collaboration is needed from target countries);
  - Local impact / issues (with the collaboration from partners from target countries)
- Session 3 (4.0h) – prepared by UMinho with the contribution of CUT in the integration of renewable energy systems section
  - nZEB renovation strategies
  - Passive and active renovation solutions towards nZEB
  - Integration of renewable energy systems – different possibilities according to the buildings needs and availability of the resource (with the collaboration from partners from target countries)
- Session 4 (2.0h) – prepared by CUT
  - Cost optimal methodology applied to the renovation of buildings
  - Life cycle costs assessment
  - Identification of the cost optimal renovation solutions
  - Difference between cost optimal solutions and net zero energy solutions
  - Cost optimal renovation solutions according to the local context (with the collaboration from partners from target countries)
- Session 5 (2.0h) – prepared by UMinho
  - Users' expectations and users' acceptance of renovation measures
  - Co-benefits associated to a renovation process
  - Drivers and barriers associated to renovation works
  - Local context (with the collaboration from partners from target countries)
- Session 6 (3.0h) – prepared by UMinho

  - Tools to support cost-effective renovation works towards nZEB
  - Practical session

- Session 7 (3.0h) – prepared by UPatras
  - Energy audits. Objectives, strategies and techniques
  - Methodology followed in energy audits
  - Parameters to be measured
  - Equipment used
  - Practical session

- Session 8 (3.0h) – prepared by UMinho
  - nZEB best practices in renovation works
  - Presentation of relevant case-studies
  - Local practice examples (with the collaboration from partners from target countries)

- Exam (1.0h) – prepared by KEK
  - One-hour written exam.

For each slide of the document, in the notes section, an explanation of what is the purpose of the slide and further notes related to the content are presented. This is intended to help the trainer to further develop the topic or to pinpoint the most relevant aspects that should be referred during the workshops and seminars. In other situations, only tables and graphs are presented in the slides, the notes sections have the most relevant aspects that must be referred by the trainer and the source (presented in a more detailed manner than the one in the slide) of the figure or table is also listed. So, if the trainer wants to further develop the content of the slide can easily find the necessary information (**Figure 1**).

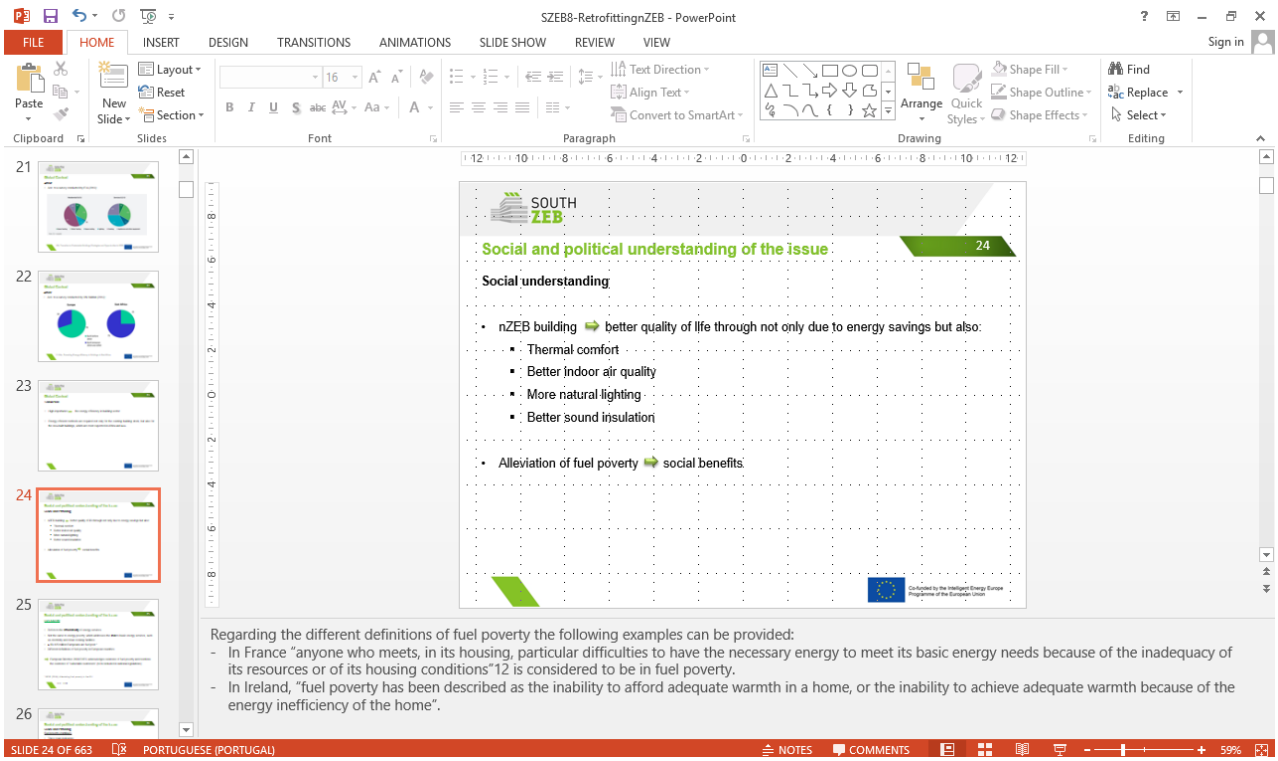

Figure 7 - Screenshot of a slide showing the slide notes

At the end of the session a list of bibliographic references are presented (**Figure 2**). The trainees can further develop their training through the analysis of the listed documents.

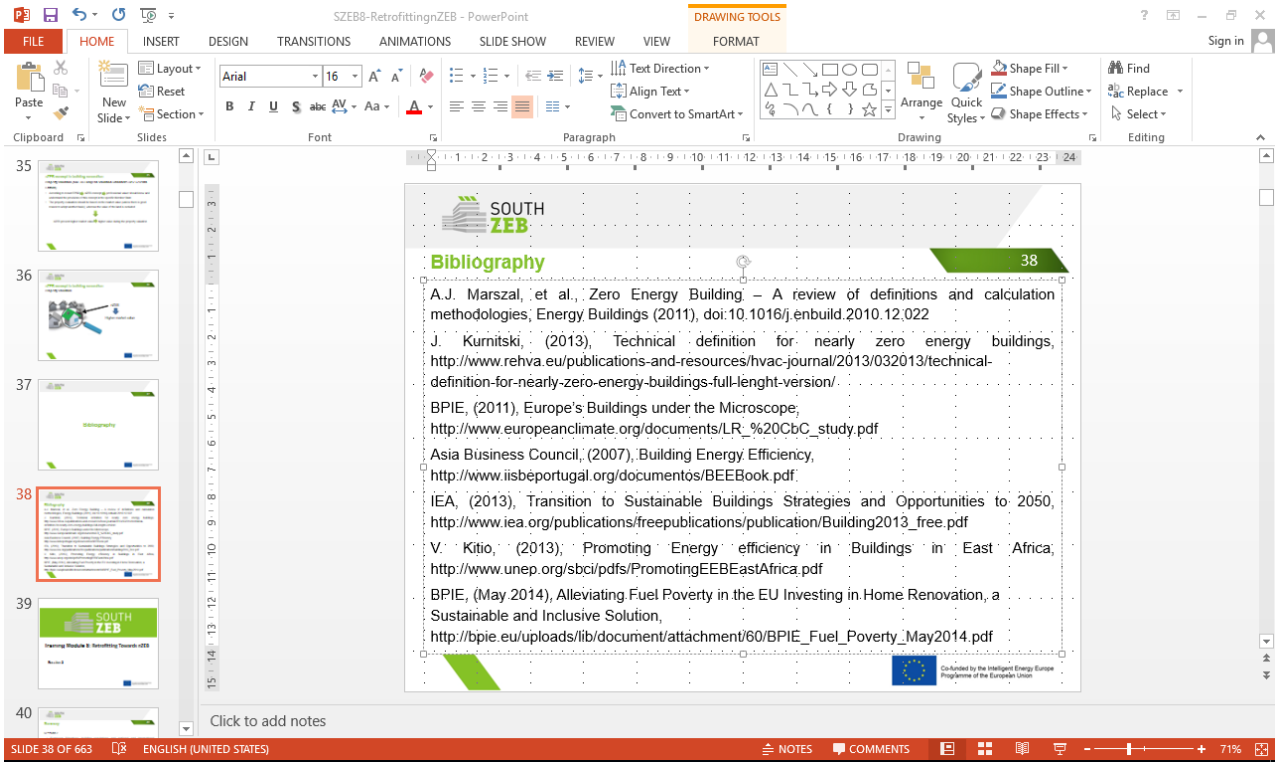

Figure 8 - Screenshot of a slide showing the bibliography related with the session

4.1 Session 1: Introduction

Learning objectives of Session 1

The learning objectives of Session 1 are as follows:

- To understand the nZEB concept applied to building renovation and the different approaches to nZEB concept;
- To identify and characterize the European building stock and its energy consumption;
- To understand the social and political understanding of retrofitting towards nZEB;
- To understand and be able to offer solutions to the technical, practical and social challenges of fuel poverty;
- To be able to communicate the benefits of nZEB renovation of buildings.

Content of Session 1 - Introduction

The first session of the training module, with forecast duration of 1.0 hours, will address the definition of the nZEB concept in the context of retrofit, in particular the following:

- Definition of the nZEB concept;
- Global context;
- Social and political understanding of the issue;
- The nZEB concept in building renovation.

The presentation explains the definition of nZEB concept, according to EPBD recast (2010/31/EU). In this session, as there is not a common definition regarding the concept nZEB, different approaches are presented (considering: the quantity and also the quality of the energy; the variety in the period of time used for calculation; the diversity of energy use; the renewable energy supply options).

The session continues with the presentation of the international context regarding the building stock and its characteristics, and energy consumption to emphasize the importance of building renovation in the global context.

The session goes on with the social and political understanding of the retrofitting towards nZEB, presenting the fuel poverty problem in Europe and the contribution of nZEB renovation to the mitigation of fuel poverty, quality of life of the population, energy savings. The benefits of nZEB renovation to health, well-being, energy savings, and property valuations are also presented.

The session ends with a list of relevant bibliography for the learners.

Learning outcomes of Session 1

The outcomes from Session 1 are as follows:

- Knowledge of the nZEB concept applied to building renovation and the different approaches of nZEB concept;
- Knowledge of the characteristics of the European building stock and its energy consumption;
- Knowledge of the social and political understanding of retrofitting towards nZEB;
- Learners will be able to offer solutions to the technical, practical and social challenges of fuel poverty;
- Learners will be able to communicate the benefits to the population of nZEB renovation;
- Learners will be able to describe the benefits of nZEB renovation to the target country.

Bibliography of Session 1

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V. Kitio, (2013), Promoting Energy efficiency in Buildings in East Africa, http://www.unep.org/sbci/pdfs/PromotingEEBEastAfrica.pdf

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4.2 Session 2

Learning objectives of Session 2

The learning objectives of Session 2 are as follows:

- To understand the nZEB definition and nZEB renovation in accordance with the EPBD recast and the Energy Efficiency Directive 2012/27/EU;
- To identify the legislation and standards, at European and national level, related to the topic;
- To understand the local traditions, context and legislation regarding retrofitting and retrofitting towards nZEB.
- To understand and be able to explain the impact and benefits of nZEB renovation to the population and to the country.

Content of Session 2

The second session of the training module, with estimate duration of 2.0 hours, will address the following:

- European Directives, building regulations and national and international standards related to the topic;
- Building traditions and local context;
- Local impact / issues.

The session's presentation starts with the nZEB definition and nZEB renovation in accordance with the EPBD recast and the Energy Efficiency Directive 2012/27/EU as well as the international standards related to the topic. The presentation continues with the presentation of the local context (national legislation, building traditions and building stock characterization, the national action plan for the progression to nearly zero-energy buildings and the benefits of nZEB renovation.

Learning outcomes of Session 2

The outcomes from Session 2 are as follows:

- Knowledge of nZEB definition and renovation in accordance with the EPBD recast and the Energy Efficiency Directive 2012/27/EU;
- Knowledge of legislation and standards, at European and national level, related to the topic;
- Knowledge of local traditions, context and legislation regarding retrofitting and retrofitting towards nZEB.
- Knowledge of the impact and benefits of nZEB renovation to the population and to the country.

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4.3 Session 3

Learning objectives of Session 3

The learning objectives of Session 3 are as follows:

- To be able to characterize the building and gather the essential information for the definition of a retrofit plan;
- To be able to identify the ways to achieve nZEB level;
- To understand and be able to offer solutions to the technical and practical challenges of the nZEB retrofit buildings;
- To identify and explain the passive and active renovations solutions towards nZEB;
- To identify the different renewable energy systems;
- To understand and explain the different needs and solutions for the integration of renewable energy systems according to the buildings needs and availability of the resources.

Content of Session 3

Session 3, with estimate duration of 4.0 hours, will address the following:

- nZEB renovation strategies;

- Passive and active renovation solutions towards nZEB;
- Integration of renewable energy systems – different possibilities according to the buildings needs and availability of the resource;
- Local context.

Session 3 starts with the presentation of the indication of the information to gather before the definition of the renovation plan. Afterwards it is explained how to achieve nZEB level in renovation works and the difference between the reduction of energy demand and carbon emissions by energy efficient measures and energy efficiency measures on building HVAC and lighting systems.

The session continues with the presentation of the energy efficiency measures related to the envelope (measures to reduce energy need for heating and measures to reduce energy need for cooling) and the energy efficiency measures on building HVAC and lighting systems (heating and cooling systems, mechanical ventilation systems and lighting systems). The technologies, techniques, materials and system advantages and disadvantages are presented and discussed.

Passive (insulation; natural light; solar gains; air tightness; natural ventilation, solar shading, chimneys and wind catchers) and active (renewable systems: solar thermal and photovoltaic, wind and hydro energy and biomass; HVAC systems; control and monitoring systems) strategies and their advantages and disadvantages are presented and discussed. Some examples of the systems are shown.

The session ends with the presentation of the local context.

Learning outcomes of Session 3

The outcomes from Session 3 are related to the planning requirements for nZEB renovation works. Learners will be able to understand and to communicate to others the main planning issues how to characterize the building and gather the essential information for the definition of a retrofit plan. They will in particular show an understanding of retrofitting of existing buildings, including how planning affects improvements to fabric, services and renewables.

Learners will be able to identify the ways to achieve nZEB level and present solutions to the technical and practical challenges of the nZEB retrofit buildings. They will also be able to explain the passive and active renovations solutions towards nZEB, namely the different renewable energy systems, presenting their advantages and disadvantages. They will show knowledge of the different needs and solutions for the integration of renewable energy systems according to the buildings needs and availability of the resources.

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4.4 Session 4

Learning objectives of Session 4

The learning objectives of Session 4 are related to the understanding of the requirements of the EPBD-recast and of the Commission delegated Regulation (EU) Nº 244/2012 concerning the cost-optimal methodology and its framework.

The learners should understand the Life Cycle Assessment (LCA) methodology and how to perform one. Learners should identify the cost optimal renovation solutions and be able to perform a cost optimal analysis and explain the differences between the cost optimal solutions and the net zero energy solutions.

They should be able to present the cost optimal renovation solutions for the target countries.

Content of Session 4

Session 4 of the training module, with estimate duration of 2.0 hours, will address renovation solutions, cost optimization and Life Cycle Assessment (LCA), in particular the following:

- Cost optimal methodology applied to the renovation of buildings;
- Life cycle costs assessment;
- Identification and characterization of the cost optimal renovation solutions;
- Difference between cost optimal solutions and net zero energy solutions;
- Cost optimal renovation solutions for Cyprus, Greece, Italy and Portugal.

Session 4 starts with the requirements of the EPBD-recast and of the Commission Delegated Regulation (EU) Nº 244/2012 concerning the cost-optimal methodology and its framework. The primary energy demand calculation, cost categories, cost calculation and critical model parameters are presented.

The presentation of Session 4 continues with the presentation of the Life Cycle Assessment (LCA) methodology. The definition of LCA, the ways for conducting an LCA, the LCA types within the process-based method, the life cycle perspective, building life cycle stages, LCA phases, impact categories and indicators, building common impact categories and indicators are presented in section 4.2. The critical model parameters and the results and interpretation are also shown in this section.

Session 4.3 is about the identification of the cost optimal renovation solutions. In this section the cost-optimal solution criteria, decision outcomes of cost-optimality, final retrofitting solution, parameters affecting financial performance and minimum renovation versus energy retrofitting are presented.

Session 4.4 addresses the cost optimal solutions and the net zero energy solutions. In this section the definition of net zero energy solution, the system boundaries, the nZEB versus cost-optimal point, the financial model driving parameters and the actions influencing driving parameters are explained.

Section 4.5 is about the cost optimal renovation solutions for Cyprus, Greece, Italy and Portugal.

Learning outcomes of Session 4

The outcomes from Session 4 will be as follows:

- To understand the requirements of the EPBD-recast and of the Commission Delegated Regulation (EU) Nº 244/2012 concerning the cost-optimal methodology and its framework;
- To understand the Life Cycle Assessment (LCA) methodology and be able to apply it;
- To identify the cost optimal renovation solutions and be able to perform a cost optimal analysis and explain the differences between the cost optimal solutions and the net zero energy solutions.
- To be able to present the cost optimal renovation solutions for the target countries.

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4.5 Session 5

Learning objectives of Session 5

The learning objectives of Session 5 are as follows:

- To understand the users' expectations and users' acceptance of renovation measures;
- To understand the co-benefits associated to a renovation process;
- To understand the drivers and barriers associated to renovation works;
- To understand and be able to offer solutions to the technical, practical and logistical challenges faced in each country in nZEB retrofit.

Content of Session 5

Session 5 of the training module, with estimate duration of 2.0 hours, will address the following:

- Users' expectations and users' acceptance of renovation measures;
- Co-benefits associated to a renovation process;
- Drivers and barriers associated to renovation works;
- Local context.

The presentation of Session 5 starts by showing the users' expectations and users' acceptance of a renovation process, discussing what influences the acceptance of the renovation process and what boost the building retrofitting acceptance.

Session 5 continues with the drivers and barriers associated to renovation works and with the discussion around the direct benefits and co-benefits from cost effective energy and carbon emissions related building renovation. The session is concluded with the local context.

Learning outcomes of Session 5

The outcomes from Session 5 will be as follows:

- To be able to explain users' expectations and users' acceptance of renovation measures;
- To be able to communicate the co-benefits associated to a renovation process;
- To be able to explain the drivers and barriers associated to renovation works;
- To understand and be able to offer solutions to the technical, practical and logistical challenges faced in each country in nZEB retrofit.

Bibliography of Session 5

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Cyprus

No relevant material

Greece

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Italy

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Portugal

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4.6 Session 6

Learning objectives of Session 6

The learning objectives of Session 6 are:

To be able to identify the most adequate tools to be used when planning cost-effective renovation works towards nZEB.

Content of Session 6

Session 6 of the training module, with estimate duration of 3.0 hours, will address the following:

- Tools to support cost-effective renovation works towards nZEB;
- Practical session.

Session 6 consists of the brief presentation of tools to support the calculation of the primary energy consumption and the life cycle costs of the retrofitting solution. A list of tools is shown and the main capabilities and outputs of each one are presented. National calculation methodologies are also analysed.

The session is concluded with a Practical Session with the development of a cost-benefit analysis of the retrofit of a building and the identification of the cost-optimal retrofit scenario.

Learning outcomes of Session 6

The outcomes from Session 6 will be as follows:

- Knowledge of the tools that are relevant to support cost-effective renovation works towards nZEB;
- Learners will be able to address the implementation of cost-effective nZEB renovation within their own work, and will allow planning future developments at this level.

Bibliography of Session 6

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Cyprus

No relevant local material

Greece

Greek Regulation for the Energy Efficiency of Buildings (KENAK)

Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B’ 1387-2010 and 1413-2012

TEE-KENAK software

Italy

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Maggioli Editore (2015), Progettare e riqualificare per l'efficienza energetica

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Portugal

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4.7 Session 7

Learning objectives of Session 7

The learning objectives of Session 7 are:

- To know the objectives, strategies and techniques of an energy audit;
- To be able to follow the methodology for energy audits;
- To be able to identify and explain the parameters to be measured;
- To be able to perform energy audits.

Content of Session 7

Session 7 of the Training Module 8, with estimate duration of 3.0 hours, will address the following:

- Energy audits. Objectives, strategies and techniques
- Methodology followed in energy audits
- Parameters to be measured

Session 7 starts with the energy audits context at European level. The definition, objectives and principles of the energy audits are then presented. The requisites of an energy auditor are also presented. The exigencies of the energy audit planning, the proposals for energy improvement and the report's content are also explained.

This session continues with the presentation of the energy audits' methodology and procedures and with the identification of the measurements and equipment needed to perform the audits. The session ends with a practical session.

Learning outcomes of Session 7

The outcomes from this session are related to the energy audits, including their objectives, parameters to be measured and methodology to be followed.

Learners will be able to understand and to communicate to others the objectives, strategies and techniques of an energy audit. They will also be able to explain the parameters to be measured and follow the methodology for energy audits. Additionally, learners will be able to analyse and explain to others the results of energy audits.

Bibliography of Session 7

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Wikipedia, (19.02.2015), Harmonics (electrical power), http://en.wikipedia.org/wiki/Harmonics_(electrical_power)

Cyprus

EN 16247-1:2012 Energy Audit. General Requirements.

EN 16247-2:2012 Energy Audit. Buildings.

In Cyprus it is mandatory by legislation to follow the methodology described in the EN16247 series when performing energy audits

Greece

Greek Regulation for the Energy Efficiency of Buildings (KENAK)

Technical Guidelines for the implementation of KENAK through Official Gazette Bulletin B' 1387-2010 and 1413-2012

Italy

Antonio Dalla (a cura di) (2010), Risparmiare energia è possibile. La gestione energetica nell'industria e nei servizi

Farné Stefano (2011), Sistemi di gestione dell'energia. La norma EN 16001: efficienza e risparmio energetico per competere

Elena Lucchi, Valeria Pracchi (a cura di) (2013), Efficienza energetica e patrimonio costruito. La sfida del miglioramento delle prestazioni nell'edilizia storica

A. Carotti (a cura di) (2014) Edifici a elevate prestazioni energetiche e acustiche. Energy management

Portugal

http://www.adene.pt/textofaqs/auditoria-energetica

4.8 Session 8: Examples

Learning objectives of Session 8

The learning objectives of Session 8 are:

To be able to identify and explain good practice examples of buildings renovation and identify the aspects that contribute to the buildings' energy efficiency.
To understand and to be able to explain the advantages of integrating renewable energy systems in buildings and to identify the best systems according with different types of buildings.

Content of Session 8

Session 8 presents a set of good practice examples, at European and national level, of buildings retrofitted to improve their energy efficiency, showing the renovation works, costs and benefits. This session has a estimated duration of 3.0h.

This session will present the following:

- nZEB best practices in renovation works;
- Presentation of relevant case-studies:
    - Multifamily Building – Kapfenberg (Austria);
    - Multifamily Building - Bruck an der Mur (Austria);
    - Single family Building - Skodsborgvej, Virum (Denmark);
    - Multifamily Building - Wijk van Morgen, Kerkrade (Netherlands);
    - Multifamily Building - Backa röd, Gothenburg (Sweden);
    - Multifamily Building - Brogården, Alingsås (Sweden);
    - Multifamily Building - Les Charpentiers, Morges (Switzerland);
- Local practice examples:

- Retrofitting Towards nZEB – Case studies – Cyprus;
- Retrofitting Towards nZEB – Case studies – Greece;
- Retrofitting Towards nZEB – Case studies – Italy: Elementary School in Laion / Novale, South Tyrol, Italy;
- Retrofitting Towards nZEB – Case studies – Portugal: Single-family Building - Pontes country house;
- Retrofitting Towards nZEB – Case studies – Portugal: Multi-family Building - Rainha Dona Leonor neighbourhood.

Learning outcomes of Session 8

The outcomes from this session are related to the identification of how it is possible to improve building characteristics during renovation to achieve nZEB.

Learners will be able to understand and to communicate to others the characteristics of buildings that contribute to the achievement of adequate nZEB renovation.

Bibliography of Session 8

Annex 56 Shining Examples, available at: http://www.iea-annex56.org/index.aspx?MenuID=4

Cyprus

No relevant local material

Greece

No relevant local material

Italy

Appiani Alessandra Renata (2011), Edifici a energia zero in Europa: casi di studio e prospettive future (pp. 117-120), Politecnico di Milano, Facoltà di Architettura e Società

Affermative Integrated Energy Design Action «AIDA» – Guida dei migliori casi studio: Storie di successo, 2013

Portugal

Annex 56 Shining Examples, available at: http://www.iea-annex56.org/index.aspx?MenuID=4

5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risks.

Risk - description	Risk Level	Risk management action
Lack of delivery of training materials by partners and complexity of developing four courses (i.e. one for each country).	High	UMinho to combine material supplied in each country with own material to create four versions of the course, one for each target country. Hold sessions on training courses at partners' meetings to resolve any issues; hold special tcfs for WP3 as required. Coordinator action as required.
Poor delivery of classroom training by target country partners and trainers	Medium	UMinho can coach the partners and the trainers through Q&A sessions by video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low - Medium	UMinho will monitor rates and amend course content to support areas where particular groups of questions are not well prepared.
Excessive differences in local issues	Low	UMinho will review local material and will advise on changes as required.

6 COMMENTS FROM EXTERNAL REVIEWER

In general, the PPT presentations for Module 8 are well structured and appropriately organized. They constitute valuable pieces of work.

Module 8 (Retrofitting towards nZEB) consists of 8 sessions; it is well structured and appropriately organised covering all aspects concerned in a very comprehensive way. There is a logical sequence of the topics elaborated and appropriate emphasis is given to each one of them. Special emphasis is also given to practical aspects, such as for example in the topic on “Retrofitting Towards nZEB: Case-Studies”.

All presentations in the 8 sessions of this Module are excellent; they are well organized and structured, including appropriately selected diagrammatic layouts, pictures and photos, to better illustrate the theoretical concepts concerned. Each presentation also includes a long list of useful bibliography.

Major topics are adequately covered in depth and width; certain topics, such as for example the one elaborating on the integration of Renewable Energies are not coved in depth but it is understood that this is not the purpose of this training course.

Overall, the presentations of all sessions in this Module are more than appropriate for the purpose proposed.

Note: The integration of renewable energies systems is not analysed in depth as it is not the main purpose of the presentation and it is covered in Training Module 2 that is mandatory.

APPENDIX I - DESCRIPTION OF MODULE 9: CONSTRUCTION MANAGEMENT & FIELD SUPERVISION

2 WP3 – TASK 2 - TRAINING MODULE 9 – CONSTRUCTION MANAGEMENT AND FIELD SUPERVISION

2.1 Preparation and delivery

Preparation of the course material is undertaken by EEG Cyprus with an assistance from a greek company Extra Mile which prepared one session of the module (Renewable Energy & Energy Storage) and a close collaboration with the rest of the consortium where necessary (in accordance with the Description of Work). The individual responsible for module 9 is Damianos Kleanthous who will be assisted by other technical colleagues with related experience where necessary. The Exams are prepared by KEK.

Local issues are determined if necessary and course material is prepared by the local partners in the target countries. Every effort should be made so content should not exceed 20% of the total course material. The local issues are prepared by local partners, CUT and EEG Cyprus in Cyprus, KEK and UPatras in Greece, DTTN in Italy and UMinho and IST-ID in Portugal.

Delivery of the training course material to trainers is undertaken in each country by the relevant partners (in accordance with the Description of Work); in Cyprus by CUT, in Greece by KEK (Euro Training), in Italy by DTTN and in Portugal by UMINHO and IST-ID. Later, the trainers will also deliver the courses to the trainees.

2.2 Outline of Module 9 – Construction Management & Field Supervision

This module aims at presenting to engineers, architects, building supervisors, site managers, building auditors the concepts of building information modelling, building envelope, mechanical, electrical and plumbing systems, renewable energy and energy storage and building automation systems. It is structured in a way to approach the design and construction of these processes of a near Zero Energy Building.

The estimated duration of the training is 40 hours, divided in pre-course preparation, classroom, post-course study and finally an exam.

This training module is coordinated, designed and planned by EEG Cyprus, with the collaboration of partners from each target country (Cyprus, Greece, Italy and Portugal) for the development of the specific training material related to local issues and particularities. As a result, the approach changes among countries in order to allow local regulations and traditions being fully adopted.

2.3 Purpose of the training

While the design of an nZEB is of a prime importance along the good integration of various technologies and the coordination of all engineering designers into the common goal, the project's operational goals will never materialize without an adequate construction management and field supervision.

In fact, successful application of design tools, high-efficiency equipment, and integrated systems is dependent upon installation. Construction firms will need to train their employees in new construction

techniques and quality control procedures. Trade coordination and cooperation will be required to meet the needs of providing a finished product for the building owner and manager that meet the objectives of NZEB technology.

The aspects that will be covered are:

- Building information modelling
- The building envelope
- Mechanical, electrical and plumbing systems
- Renewable energy and energy storage
- Building automation systems

2.4 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience (course, webinar, self-study or group activity). Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experiences.

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials.

Learning objectives:

- Provide clarity about the purpose of the course;
- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals;
- Establish accountability between the learner and the instructor;
- Help trainers articulate exactly what they want participants to do by the end of the training.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound.

The learning objectives of Module 9 are as follows (specific):

- Demonstrate construction experience and knowledge to prospective employers in the industry.
- Analyze and interpret construction blueprints and other job orders.
- Compare and contrast conventional construction materials and methods with those of nZEB.
- Understand various EE and RE technology and their related Construction Management for optimal results.
- Manage various relationships between designers, owners, contractors and suppliers.

Measurable – learners, after completing the course, are able to identify the key parameters and requirements that lead to the design of a near Zero Energy Building and the resulting benefits (financial and more) to its owners, tenants, managers, etc. Learners will also be able to follow various design paths leading to the design of an nZEB building using the most adequate methodology.

Action – learners will be able to address the implementation of nZEB development within their own work, taking into consideration the various particularities and different possibilities in each particular case study.

They will also be able to explain to prospective clients, colleagues and other stakeholders the issues involved in the design and development of an nZEB building.

Reasonable – PowerPoint slides are supported by reading documents recommended to be studied before and after attending the course and additional material is presented as bibliography in each section; the learning required is commensurate with the objective.

Time-bound – learning will be completed after the training and completion of course reading.

2.5 Learning audience – trainers and trainees – qualifications and experience

The trainers and trainees will be those professionals involved in the design and construction of buildings, as well as those involved in the building regulation system. Professions will include engineers, architects, building supervisors, site managers and building auditors. Government and local authorities officials involved in the regulation of energy efficient buildings will also be included.

The trainers should be members of a relevant construction profession and have extensive experience, at least five years' experience in practice of the design and construction of buildings, preferably of energy efficient buildings. Experience of supervision of staff and previous experience in delivering training and courses would also be useful.

The trainees include the building professionals described above, but with any number of years' experience from graduation through to senior company Directors.

3 STRUCTURE OF MODULE 9 – CONSTRUCTION MANAGEMENT AND FIELD SUPERVISION

The estimated duration of the training is 40 hours. The structure of the training course is as follows:

- **Preparation** – involving an on-line introduction and background reading. The approximate duration is 5 hours;
- **Class based training** – involving delivery by a trainer of the main components of the training. The delivery will be given by the approved trainer in modules split in 2-hour sessions. The approximate duration of the classroom training will be 30 hours;
- **Post classroom based training, self-learning and exam preparation**. The training will include on-line reading and, where possible, video presentation from actual building examples to demonstrate good and bad practice, as well as short self-assessment tests, based on the contents and functionalities of the e-learning platform. The approximate duration of this part of the training will be 4 hours;
- **Competence assessment**: this will be delivered through a one hour written exam after the completion of the training course and will be structured in a combination of multiple-choice questions and calculation questions. 1 hour should be allocated to complete the exam.

3.1 Time Allocation of Module 9 - Construction Management & Field Supervision

It is foreseen to have 30 hours of class room training, distributed per section as follows, and an 1 hour exam:

- Session 1 – Building Information Modeling (5.0h)
- Session 2 – The building envelope (6.0h)
- Session 3 – Mechanical, Electrical & Plumbing Systems (7.0h)
- Session 4 – Renewable Energy & Energy Storage (7.0h)
- Session 5 – Building Automation Systems (5.0h)
- Exam (1.0h)

3.2 Course reading material

A number of documents are indicated as necessary (pre-course and post-course) and additional reading material related to legislation, building certification and key parameters, European Directives, etc. is pointed out.

Pre-classroom

Cyprus

2010/31/EU Directive of the European Parliament and of the Council on the energy performance of buildings (recast)

Energy-Efficient Building Systems:Green Strategies for Operation & Maintenance Jayamaha, L. 2006. McGraw-Hill ISBN: 978-0071482820

Building Automation Integration with Open Protocols NJATC, 2009. Amer Technical Pub ISBN: 978-0826920126

Intelligent Buildings and Building Automation Merz, M., Hansemann, T., Hübner, C. 2009, Springer ISBN: 978-3540888284

Greece

A. Tsikalakis, (n.d.), *Information Systems for Building Management & Automation*, https://eclass.teicrete.gr/modules/document/file.php/TH132/BMS_Ktiria.pdf

I. Sofronis, 8-10/03/2010, *Energy saving in Buildings with the use of Automation Systems*, http://library.tee.gr/digital/m2483/m2483_sofronis.pdf

Italy

Di Giuda Giuseppe M., Villa Valentina (2016), Il BIM: Guida completa al Building Information Modeling per committenti, architetti, ingegneri, gestori immobiliari e imprese, Hoepli ed.

Sferra Adriana S. (2015), Ultima chiamata: uscita 2020. La scadenza europea per la sostenibilità ambientale, Franco Angeli ed.

Guida Pier Luigi, Ortenzi Antonio (2016), Project Management in edilizia e nelle costruzioni civili, DEI – Tipografia del Genio Civile

Portugal

Portuguese Energy Strategy (NES 2020)
Portuguese Building Thermal Legislation - Decree-Law 118/2013, Updated by Decree-Law 68 -A/2015, Decree-Law 194/2015, Decree-Law 25/2016 and related Ordinances and Mandamus.
National Energy Efficiency Action Plans (NEEAP) and National Renewable Energy Action Plans (NREAPs)

Post classroom

The post classroom reading includes the following:

Building Envelopes: An Integrated Approach (Architecture Briefs) Lovell, J. 2012. Princeton Architectural Press. ISBN: 978-1568988184

Passive Houses: Energy Efficient Homes Van Uffelen, C. 2012. Natl Book Network ISBN: 978-3037681060

Net Zero Energy Design: A Guide for Commercial Architecture Hootman, T. 2012. ISBN: 978-1118018545

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4 CONTENT OF MODULE 9 – CONSTRUCTION MANAGEMENT AND FIELD SUPERVISION

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content will be split into five sessions that will be run over the entire training course duration. Each session will be introduced by the trainer and the connection with the learning objectives and outcomes explained. The sessions will vary in timing and content. The course material will be delivered through PowerPoint slides, which are made available to the trainees. The trainers have additional notes available to them on the PowerPoint slides.

The sessions are described in this section, including relevance to the objectives and the learning outcomes.

The five sessions are as follows:

- Session 1 – Building Information Modeling (5.0h) – prepared by EEG Cyprus
    13. The Basics
    14. Applying Building Information Modeling
    15. Building Information Modeling Features
    16. Global Adoption, Codes & Standards
    17. Implementation
    18. Case Studies
    19. Building Information Modeling in Zero Energy Buildings
    20. Building Information Modeling's role in Construction Management
    21. Learn More
    22. Bibliography

- Session 2 – The building envelope (6.0h) - prepared by EEG Cyprus
    18. Basic definitions
    19. Introduction to building envelope
    20. Building envelope technologies
    21. Policies, Codes & Regulations
    22. Market & Potential
    23. Case studies
    24. Construction Management
    25. Learn more
    26. Bibliogrpahy

- Session 3 – Mechanical, Electrical & Plumbing Systems (7.0h) - prepared by EEG Cyprus
    20. Basic definitions
    21. Mechanical, Electrical & Plumbing systems in a Glance
    22. Mechanical, Electrical & Plumbing design aspects
    23. Mechanical, Electrical & Plumbing efficiency & optimization
    24. Construction Management
    25. Commissioning
    26. Learn more
    27. Bibliography

- Session 4 – Renewable Energy & Energy Storage (7.0h) - prepared by Extra Mile
    28. Introduction
    29. Solar Thermal Systems

30. Biomass boiler and Combined Heat and Power
31. District Heating and Cooling
32. Geothermal Heat Pumps
33. Thermally Activated Building Structures
34. Solar Chimney
35. Building Integrated Photovoltaics
36. Photovoltaics
37. Wind Farms
38. Hybrid Systems
39. Construction Management and Renewable Energy implementation: Electrical energy, thermal energy
40. Bibliography

- Session 5 – Building Automation Systems (5.0h) - prepared by EEG Cyprus
  34. Basic definitions
  35. Introduction to building automation
  36. Building automation to near Zero Energy Building
  37. Standards & Regulations
  38. Commissioning
  39. Case studies
  40. Learn more
  41. Bilbiography

- Exam (1.0h) - prepared by EEG Cyprus (from pool of questions prepared by KEK)

  One-hour written exam.

In some slides of the document, in the notes section, a further explanation of the slide and further notes related with the content are presented. This is used to help the trainer to further develop the topic or to pinpoint the most relevant aspects that should be referred during the workshops and seminars. In other situations, only tables and graphs are presented in the slides, the notes sections have the most relevant aspects that must be referred by the trainer and the source (presented in a more detailed manner than the one in the slide) of the figure or table is also listed. So, if the trainer wants to further develop the content of the slide, he/she can easily search for the document (**Figure 1**).

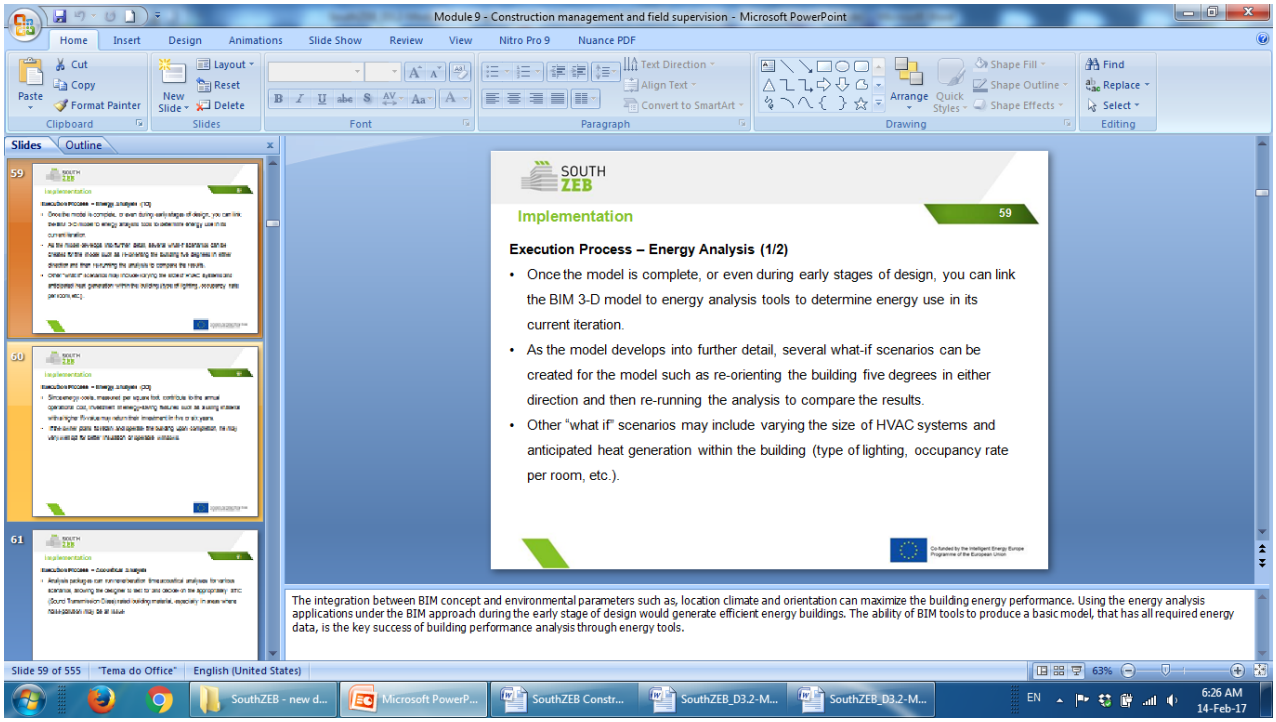

Figure 9 - Screenshot of a slide showing the slide notes

At the end of the session a list of bibliographic references are presented (**Figure 2**), the trainees can further develop their training through the study of the documents listed.

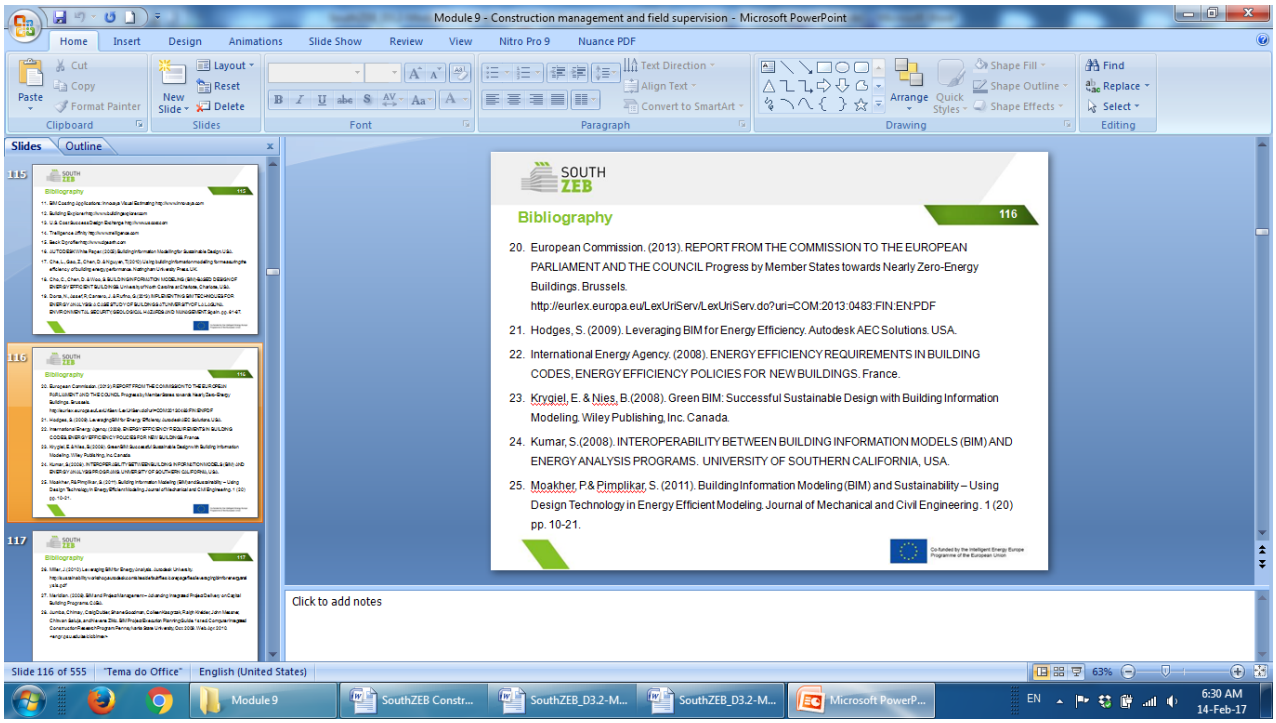

Figure 10 - Screenshot of a slide showing the bibliography of the session

4.1 Session 1: Building Information Modelling

Learning objectives of Session 1

The learning objectives of Session 1 are as follows:

- To understand the definition and concept of building information modelling.
- To understand how to apply and implement on nZEB buildings and construction management.

Content of Session 1

The first session of the training module addresses on defining, explaining and using the building information modelling on the construction of nZEB buildings

- Introduction to the topic
- Concept and definition of building information modelling
- Applying and implementing building information modelling on the construction management of nZEB buildings

The presentation explains what is building information modelling through definition and clarification of what is not considered one to avoid confusion and then how to use it and the role of each group of people such as architecture, electrical and mechanical engineers, etc involved in the design and construction of the building on the modelling. Furthermore, implementation and case studies are presented for further understanding it and by showing how to perform various scenarios how the optimal energy design can be achieved that helps to design and construct an nZEB building.

Session's 1 estimated duration is 5.0 hours.

Summary of Session 1

The common strength of the BIM process is the ability to run "what if" scenarios to determine the optimum energy design. During design and construction, all building data such as materials, geometric information, chosen systems of design, spaces, facility are required to be accessible in order to evaluate the building various performance for instance, the energy performance. It can be easily updated on any changes on the design and automatically readjust all the affected areas. It helps coordinate the work of subcontractors. Construction managers or general contractors can use BIM to extract quantities of work to prepare cost estimates.

Learning outcomes of Session 1

The outcomes from Session 1 will be as follows:

- Knowledge of the concept and definition of building information modelling;
- Knowledge of implementing the building information modelling on constructing nZEB buildings;

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4.2 Session 2: The building envelope

Learning objectives of Session 2

The learning objectives of Session 2 are as follows:

- To familiarize and learn the terms of building envelope and everything related with heat losses/gain on the envelope.
- To familiarize with building envelope technologies and case studies.
- To learn and understand policy, codes and regulations on Energy Performance of Buildings Directive.

- To learn and understand the roles of all people involved during the construction management and field supervision and the different phases of the process.

Content of Session 2

The second session of the training module is about understanding the terms of heat losses/gain from materials used on the building envelope and familiarize with the heat transfer factors of each material (U-value and R-value). Building envelope technologies such as insulation materials are presented and case studies are shown. The Energy Performance of Buildings Directive is presented in general. The roles and responsibilities of the people in the construction management are presented. An explanation and analysis of all the phases for the construction management such as from the procurement phase to products receipt and acceptance phase to construction supervision and monitor phase all the way to the commissioning phase for testing and tools to be used are shown.

Session's 2 estimated duration is 6.0 hours.

Summary of Session 2

Thermal losses/gain of the building envelope is based on the heat transfer factor of each material (R-value) that will show the U-value of the envelope. Technologies regarding the building envelope based on the climate of the region are thermal insulation materials used such as cellulose, fibreglass, mineral wool, polyurethane foam, etc. air sealing, windows glazing and materials for the roof. The construction management phases are procurement, products receipt and acceptance, construction supervision and monitoring, pre-commissioning and commissioning.

Learning outcomes of Session 2

The outcomes from Session 2 will be as follows:

- Knowledge on the thermal losses/gain of the building envelope and different technologies used to prevent this;
- Knowledge of related EU directive on the energy performance of buildings;
- Knowledge on the different phases of the construction management and field supervision;

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4.3 Session 3: Mechanical, Electrical and Plumbing Systems

Learning objectives of Session 3

The learning objectives of Session 3 are as follows:

- To understand the design aspects of mechanical, electrical and plumbing systems
- To understand the efficiency and optimisation of mechanical, electrical and plumbing systems
- To understand thoroughly the commissioning methodology of mechanical, electrical and plumbing systems during construction and usage.

Content of Session 3

The third session of the training module is about breaking down the mechanical, electrical and plumbing systems and explain their operation and purpose of usage during the design aspect. Then, ways to improve

the efficiency and optimisation of these systems is presented. A thorough analysis is presented on commissioning and its different types for ensuring the systems perform as per the design criteria.

Session's 3 estimated duration is 7.0 hours.

Summary of Session 3

The design aspects of the mechanical, electrical and plumbing systems are defined and ways to improve their efficiency and optimisation are explained such as variety of cooling strategies, dehumidification, ventilation, etc. lighting loads, HVAC systems, etc. Commissioning is a systematic process of ensuring, verifying and documenting that a building facilities and systems performs in accordance with the design intent, contract documents, and the owner's operational needs.

Learning outcomes of Session 3

The outcomes from Session 3 will be as follows:

- Knowledge on the mechanical, electrical and plumbing systems aspects and ways to optimise them and make them more efficient;
- Knowledge on the different phases of the construction management and field supervision mostly through commissioning;

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4.4 Session 4: Renewable Energy & Energy Storage

Learning objectives of Session 4

The learning objectives of Session 4 are as follows:

- To understand the solar thermal systems.
- To learn the combi systems, types of boilers, geothermal, all types of photovoltaics, wind farm, etc.
- To understand the commission methodology for the construction management of these types of systems.

Content of Session 4

The content of the fourth session of the training module is about learning the solar thermal systems (passive and active) and explanation of the heating and cooling systems. The analysis of the various phases during the construction management was explained for these systems such as inspections and tests.

Session's 4 estimated duration is 7.0 hours.

Summary of Session 4

Solar thermal systems use the solar irradiation in order to produce heat and power residential and industrial heating and cooling systems with the aid of solar collectors. The solar thermal systems consist of the passive and the active systems. Passive systems do not require mechanical devices or the use of the conventional energy sources. Active solar thermal systems are more complex than passive solar thermal systems and use external sources of energy to power blowers, pumps and other types of equipment to collect, store and convert solar energy. Some examples presented and analysed are types of boilers, geothermal, solar chimney, solar thermal collectors, building integrated photovoltaics, wind farms, etc. The construction management phases are procurement, products receipt and acceptance, construction supervision and monitoring, pre-commissioning and commissioning which inspections and tests are furthered analysed.

Learning outcomes of Session 4

The outcome from Session 4 will be as follows:

- Knowledge on the solar thermal systems both passive and active;
- Learn the various heating and cooling systems, photovoltaics, wind farms;
- Knowledge on the different phases of the construction management and through commissioning the inspections and tests needed for these type of systems;

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4.5 Session 5: Building Automation Systems

Learning objectives of Session 5

The learning objectives of Session 5 are as follows:

- To familiarize with building automation systems
- To understand how to use building automation systems in an nZEB building and its benefits
- To learn the regulations and standards and the different protocols of building automation systems

Content of Session 5

The fifth session of the training material is about understanding the basic knowledge of building automation systems that must be included during the construction stage of a building in order to help facility management operate and better maintain it. The European regulations and standards are presented and many protocols are explained based on the different needs of the building whether it is an office or industry etc. Furthermore, some case studies were shown how the building automation system was used in specific type of buildings.

Session’s 5 estimated duration is 5.0 hours.

Summary of Session 5

Building automation system is a computerized intelligent network of electronic devices designed to monitor and control the mechanical, electronic, and electrical systems in the building. The regulation EN 15232:2012 was analysed and some protocols explained such as BACnet, 1-Wite, C-Bus, DALI, DSI, KNX, etc.

Learning outcomes of Session 5

The outcome from Session 5 will be as follows:

- Knowledge on the building automation systems and the installation protocols and regulations needed based on the building needs.

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5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risk.

Risk - description	Risk Level	Risk management action
Lack of delivery of training materials by partners and complexity of developing four courses (i.e. one for each country).	Medium - High	EEG Cyprus to combine material supplied in each country with own material to create four versions of the course, one for each target country. Review of relevant developed material by partners in each target country for identification of possible errors and misleading information. Hold special TCFs for WP3 in case of serious deviations. Coordinator action as required.
Poor delivery of classroom training by target country partners and trainers	Medium	Front runner countries are expected to assist the partners in the target countries and the trainers through Q&A sessions by video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low - Medium	EEG Cyprus will support partners in areas where particular groups of questions are not well prepared.
Excessive differences in local issues	Low	EEG Cyprus will review local material and advice on changes as required.

6 COMMENTS FROM REVIEWERS

No additional comments were received from the reviewer regarding the training material of the powerpoint slides.

APPENDIX J - DESCRIPTION OF MODULE 10: FUNDING & INCENTIVES

2 WP3 – TASK 2 - TRAINING MODULE 10 – DESCRIPTION

2.1 Outline of module 10

Module 3 aims to present to local and national authorities' representatives a range of tools, mechanisms and incentive schemes designed to facilitate the increased uptake of energy efficiency and low carbon technologies and/or green improvement plans for buildings. These mechanisms can potentially inform the design of similar measures, by policymakers in the Southern countries, to assist the development of energy efficient design and nZEB solutions. The module is aimed at local and national authorities' representatives involved in either developing / financing energy efficiency and nZEB solutions or in developing / managing finance mechanisms for the sustainable built environment. The module provides a brief introduction to key policy and legislation issues, before introducing a range of funding and incentive categories including: energy supplier obligation schemes, loan / finance schemes and green investment funding schemes, financial incentives for low carbon energy systems; and tax break and fuel levy breaks. Learning is reinforced via the provision of a number of specific schemes under each category, as well as facilitated discussion on related financial mechanisms specific to the local country.

This training module has been coordinated, designed and planned by BRE, with input from the partners from each country (Cyprus, Greece, Italy and Portugal) to revise and/or develop specific training material related to their own country. As a result the approach changes between countries in order to allow for local regulations, traditions and opportunities to be fully explained.

The estimated training duration is 20 hours.

2.2 Purpose of the training

Presently, it can be difficult to encourage property owners, developers or occupants to design and develop new building in a sustainable manner, particularly as investing in 'green' measures can often be cost prohibitive. In order to encourage 'green' investment in buildings and reduce the environmental impact of emissions relating to building energy use, incentives are often required. As such, a wide variety of funding schemes and other incentives are key to encouraging 'green' investment and low carbon design and development. The purpose of this module is give attendees an understanding of these issues and to introduce them to a range of low carbon energy, or green, finance mechanisms and other incentives, with a view to enabling countries to replicate or adopt similar incentives and mechanisms suited to their specific nZEB aims and requirements.

2.3 Learning objectives and outcomes

Learning objectives specify the new knowledge, skills and abilities that a learner should accomplish from undertaking a learning experience, such as a course, webinar, self-study or group activity. Achievement of all of the learning objectives should result in accomplishing all of the overall training goals of the training and development experience(s).

A learning objective is a statement of what the learner will know, understand, or be able to do as a result of engaging in a learning activity. Well-written learning objectives are essential to building a strong foundation in the development of training materials. Learning objectives:

- Provide clarity about the purpose of the course.

- Guide the development of appropriate content, methods, and materials by the curriculum developer in order to facilitate learning and meet training goals.
- Establish accountability between the learner and the instructor.
- Help trainers articulate exactly what they want participants to do by the end of the training.

Effective learning objectives have been developed using the SMART principles: Specific, Measurable, Action-oriented, Reasonable, and Time bound.

The learning objectives of Module 3 are as follows:

- Objective 3.1 – to be introduced to, and understand the operation of, a range of energy efficiency obligation schemes, funding schemes, and other related incentives; including understanding their structure, operation, benefits and risks. In addition, to appreciate the legislation, or other underlying drivers, driving the schemes and, through a series of case studies, understand their application and potential impact.
    - Measurable – learners will gain awareness of the wide range of funding schemes, mechanisms and incentives of particular relevance to nZEBs and low carbon building design and operation.
    - Action – learners will be able to apply awareness of these mechanisms within their own work, enabling them to make use of available schemes to reduce the impact of future developments, or enabling them to be instrumental in developing similar mechanisms in their own country, region or municipality.
    - Reasonable – powerpoint slides are supported by learning documents available via the website, the learning required is commensurate with the objective.
    - Time-bound – learning will be completed after the training and completion of course reading.
- Objective 3.2 - To enable the trainee to discuss the range of finance mechanisms and incentive schemes, and to consider their relevance, or use, in their local country.
    - Measurable – after gaining awareness of the funding schemes as above, learners will engage in group discussion to consider the mechanisms and debate their application/use/relevance/operation in their local context.
    - Action – learners will be able to apply awareness of these mechanisms within their own work, enabling them to make use of available schemes to reduce the impact of future developments, or enabling them to be instrumental in developing similar mechanisms in their own country, region or municipality.
    - Reasonable – powerpoint slides are supported by learning documents available via the website, the learning required is commensurate with the objective.
    - Time-bound – learning will be completed after the training and completion of course reading.

2.4 Learning audience – trainers and trainees – qualifications and experience

The trainers and trainees will be those building professionals or financiers involved in the built environment, as well as those involved in the building regulation system. Government and local authority officials involved in the development and/or regulation of near zero energy buildings or the funding of ‘green’

development should also be included. Professionals that will benefit from an understanding of this subject will include Government and local authority officials involved in building development, procurement and design; developers; architects; architectural technologists; engineers (mechanical, electrical and structural); building supervisors; and other building professionals.

The trainers should be members of a relevant construction, construction regulation or green financial profession and have at least five years' experience in the area of energy / built environment. Experience of supervision of staff and previous experience in delivering training would also be useful.

The trainees include the building professionals described above, but with any number of years' experience from graduation through to senior company Directors.

3 STRUCTURE OF MODULE 10

The structure of the training course is as follows:

- Preparation – involving an on-line introduction and background reading, the approximate duration is 4 hours.
- Class based training – involving delivery by a trainer of the main components of the training. The delivery will be given by the approved trainer to between 10 and 20 trainees at each session. The approximate duration of the classroom training will be 10 hours, as follows:
    - Session 1 – Context & Background (0.5h)
    - Session 2 – Funding and Incentives Schemes (by type)
        - Energy Supplier Obligations (+ examples) (2h)
        - Loan / Finance Scheme & Green Investment Funds (+ examples) (1.0h)
        - Financial Incentives (renewable energies) (+ examples) (1h)
        - Tax Incentives / Fuel Levy Incentives (+ examples) (1h)
    - Session 3 – Local Country specific mechanisms (3.5h)
    - Session 4 – Discussion (1h)
- The training and self-learning will include review of classroom material and additional reading on the issues covered within the module content. The approximate duration of this part of the training is 3 hours. Attendees will also need to dedicate approximately 2 hours to prepare for the competency assessment. The duration of the post classroom training, self-learning and exam preparation is therefore approximately 5 hours.
- Competence assessment – this will be delivered through a one hour written exam that will involve a multiple-choice exam. The assessment will take 1 hour to complete.

3.1 Course reading material

Pre-classroom

- European Commission website – financing energy efficiency (including “Smart financing for smart buildings imitative”) -
- https://ec.europa.eu/energy/en/topics/energy-efficiency/financing-energy-efficiency
- (Report) Financial support for energy efficiency in buildings, European Commission, COM (2013) 225 - https://ec.europa.eu/energy/sites/ener/files/documents/report_financing_ee_buildings_com_2013_225_en.pdf

- European Commission website – financing renovations - https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings/financing-renovations

- National Government (or delegated parties e.g. regulators) websites, guides or regulations relevant to incentives for energy efficiency design, implementation and improving the energy performance of buildings.

Cyprus

- ΚΔΠ 119/2016 – On the Regulation of the Energy Performance of Buildings (Requirements on the Minimum Energy Performance of Buildings) Decree 2016.

- Circular 1/2014 – Incentives on use of RES in buildings (minimum requirements of 25% RES and Energy Category A)

Greece

- "Saving energy at home" - http://84.205.246.56/Default.aspx?tabid=526&language=el-GR

- GRE18-Energy Upgrading of social housing- The "Green Neighborhoods"" Program

- Obligatory installation of central thermal solar systems in residential and tertiary buildings, through the Greek Law 3851/2010

- Incentive in increasing the permissible building factor in energy efficient buildings (category A+ or more (primary energy less than 10kWh/m2/year) through the New Building Regulation 4067/2012

- Energy audits and obligation of EPCs in all new, fully-renovated residences and in tertiary section and in all buildings for sale and renting according to Greek Law "KENAK" and 4122/2013 -http://portal.tee.gr/portal/page/portal/tptee/totee/FEK%20407-B-2010%20-%20KENAK.pdf- http://portal.tee.gr/portal/page/portal/tptee/images_banners_etc/adverts_banners/fg.pdf

Italy

- Pierluigi Piselli (2011), *Il contratto di rendimento energetico. Energy performance contract*, Utet Scienze Tecniche

- Adriana S. Sferra (2013), *Obiettivo "Quasi Zero". Un percorso verso la sostenibilità ambientale*, Franco Angeli

- Mario Pagliaro (2012), *Energy manager: Una professione vincente al servizio di imprese ed enti pubblici*, Simplicissimus Book Farm srl

- Antonella Antonelli (2013), *I Finanziamenti della Comunità Europea. I consigli e le informazioni utili per attingere ai fondi stanziati dalla Comunità Europea*, B2corporate

Portugal

- (Website) Energy Efficiency Fund (FEE - Fundo de Eficiência Energética) - http://www.pnaee.pt/fee
- (Website) Portugal 2020 – http://www.portugal2020.pt
- (Website) Promoting Efficiency in Electricity Consumption (PPEC - Plano de Promoção da Eficiência no Consumo) - http://www.erse.pt/pt/planodepromocaodaeficiencianoconsumoppec/ppec1314/Paginas/default.aspx
- (Website) Innovation Support Fund (FAI - Fundo de Apoio à Inovação) - http://fai.pt/

Post classroom

- European Commission website – financing energy efficiency – https://ec.europa.eu/energy/en/topics/energy-efficiency/financing-energy-efficiency
- (Website) De-risking Energy Efficiency Platform (DEEP) - An open-source initiative to up-scale energy efficiency investments in Europe through the improved sharing and transparent analysis of existing projects in Buildings and Industry - https://deep.eefig.eu/

Cyprus

- National Strategy in mobilizing investments in the sector of buildings' energy retrofits.

Greece

- Report regarding the longterm strategy for stimulation of the incentives for the renovation of the existing building stock, by Energy Ministry - http://84.205.246.56/LinkClick.aspx?fileticket=XLqxHeSJDdA%3d&tabid=282&language=el-GR
- Measures on energy efficiency and renewable energy in buildings by Odyssee-Mure - http://www.measures-odyssee-mure.eu/topics-energy-efficiency-policy.asp
- News regarding energy efficient policies - http://84.205.246.56/Default.aspx?tabid=281&language=el-GR

Italy

- Nevin Cohen (a cura di) (2011), *Green Business: An A-to-Z Guide*, SAGE Publications
- Elpidio Natale, Alessandra Daolio (2013), *Le ESCo (Energy Service Company) per l'efficienza energetica. Il risparmio garantito senza rischi per il cliente*, Maggioli editore
- Mario Pagliaro (2012), *Energy manager: Una professione vincente al servizio di imprese ed enti pubblici*, Simplicissimus Book Farm srl
- Marino Cavallo, Piergiorgio Degli Espositi, Kostas Konstantinou (a cura di) (), *Green marketing per le aree industriali. Metodologie, strumenti e pratiche*, Franco Angeli

- Antonella Antonelli (2013), *I Finanziamenti della Comunità Europea. I consigli e le informazioni utili per attingere ai fondi stanziati dalla Comunità Europea*, B2corporate

Portugal

- National Action Plan for Energy Efficiency (PNAEE - Plano Nacional de Acção para a Eficiência Energética) - https://ec.europa.eu/energy/sites/ener/files/documents/2014_neeap_pt_portuga.pdf

- Energy Efficiency Fund (FEE - Fundo de Eficiência Energética) - https://dre.pt/application/file/485568

- Portugal 2020 - https://www.portugal2020.pt/Portal2020/Media/Default/Docs/1.%20AP_Portugal%202020_28julho.pdf

- Promoting Efficiency in Electricity Consumption (PPEC - Plano de Promoção da Eficiência no Consumo) - http://www.erse.pt/pt/legislacao/diplomas/Documents/Efici%C3%AAncia%20Energ%C3%A9tica/Portaria%2026_2013.pdf

4 CONTENT OF MODULE 10

This section provides the lesson plan, including a description of the areas and the key points to be covered.

The presentation content will be split into three sessions that will be run over the day. Each session will be introduced by the trainer and the connection with the learning objectives and outcomes explained. The sessions will vary in timing and content. The course material will be delivered through PowerPoint slides, which will be made available to the trainees. The trainees will have additional notes available to them on the PowerPoint slides.

The sessions are described in this following sections, including relevance to the objectives and the learning outcomes.

4.1 Session 1: Context and Background

Learning objective

- To introduce attendees to background, context and key EU policy and legislation issues surrounding the need for increasing energy efficiency, decarbonising the building environment and developing nZEBs.
- To draw attention to the need for effective finance mechanisms, regulation or incentives to facilitate the move to a low carbon built environment.

Content

In this session attendees will be introduced to Global and EU energy and sustainability issues, and targets, to provide context and background to the need for EU member states to improve building performance and energy efficiency and reduce carbon emissions. Trainees will understand that across Europe buildings represent the largest share of energy consumption and carbon emissions therefore significant focus is needed in this sector in order to achieve the EU goals. The trainer will also highlight the EU Roadmap to a Resource Efficient Europe. As well as the improvements in energy consumption and carbon emissions the trainer will explain some of the other benefits to improving building energy performance e.g. increased comfort, healthy spaces, better working environments, etc.

Following this attendees will be introduced to some of the aforementioned issues albeit within the context of an individual EU member state. The UK is used as an example and attendees are introduced to UK drivers for change which include government policy objectives, legislation and regulations e.g., Climate Change Act 2008, Renewable Energy Directive, and highlight how this has led to the implementation of a number of regulatory schemes and incentives scheme aimed at improving the energy performance of buildings and increasing energy efficiency and renewable energy generation. Additional background and context relevant to the local country is also introduced.

Learning outcomes

The outcomes from Session 1 will be as follows:

- Attendees will have developed knowledge and awareness of key EU carbon targets, and be aware of the role that building energy performance has to play (and its significance). This will ensure

attendees can apply cognisance of these issues in their work as well as have knowledge of the key legislation and related local policy instruments.

- Attendees will develop an awareness of the importance of effective drivers and other enablers, such as finance mechanisms, regulation or incentives to facilitate the move to a low carbon built environment, enabling them to consider the application and use of similar drivers in their local country.

4.2 Session 2: Funding and Incentive Schemes (by type) (including examples)

Learning objective

The learning objectives of Session 2 are as follows:

- To introduce attendees to, and develop their understanding of, a range of energy efficiency obligation schemes, funding schemes, and other related incentives that can support low energy building design and operation and the development of nZEBs.
- To provide attendees with an overview of the structure, operation, benefits and risks of a variety of schemes and mechanisms.

Content

Session 2 provides an overview of a range of regulatory obligations, financial mechanisms and incentives roughly categorised in 4 x different group / types of schemes. Each of the four schemes are introduced including a number of sub-schemes types which are supported and explained in more detail by means of examples. The structure of the session is as follows:

- Energy Supplier Obligations
    - Carbon Emissions Reduction Schemes.
        - Example: UK Carbon Emissions Reduction Target
    - Community Energy Schemes. Example:
        - Example: UK Community Energy Savings Programme
    - Other Energy Company Obligations Schemes. Example.
        - ECO
- Loan / Finance Scheme & Green Investment Funds
    - Loan Schemes.
        - Example: UK SALIX scheme and recycling fund
    - Finance Schemes

        - Example: Green Deal
        - Example: Energy Performance Contracts
    - Green Investment Funds
        - Examples: European Investment Bank, European Energy Efficiency Fund, UK Green Investment Bank
- Financial Incentives (renewable energies)
    - Clean energy cashback schemes
        - Example: Feed in tariffs
        - Example: Renewable Heat Incentive
- Tax Incentives / Fuel Levy Incentives
    - Tax relief for energy efficient equipment
        - Example: UK Enhanced Capital Allowance scheme
    - Tax relief for fuel bills
        - Example: UK Climate Change Agreement

The training module addresses the following:

<u>Energy Supplier Obligations</u>

Session 2-1 will look at different energy supplier obligations that are currently in effect, using the UK as an example, as well as some of those previously adopted. This will include a look at carbon emissions reduction schemes, community energy schemes, as well as some other Energy Company Obligations including highlighting how UK based schemes have developed over the years.

The trainer will begin the session with a look at carbon emissions reduction schemes and will firstly explain what these are in the context of carbon emission targets. This will include highlight the target groups, products / technologies and how schemes can be designed to provide benefits to specific groups e.g. vulnerable households, poorer performing buildings, etc. Following this overview of energy supplier obligations the trainer will then give specific examples of current or previous obligations.

The first example the trainer will introduce is the UK Carbon Emissions Reduction Target (CERT) scheme. It will be explained that this was established to give gas and electricity suppliers targets for reducing carbon emissions from domestic properties. The trainer will go into more detail about the actions suppliers had to take, including delivery mechanisms, in order to comply with the Order as well as highlight the outcomes and results from the scheme.

Another scheme the trainer will introduce in this module is the Community Energy Saving Programme (CESP) which was created as part of the UK governments Energy Saving Programme. This scheme required gas and electricity suppliers and electricity generators to deliver energy saving measures to domestic consumers in specific low income areas of Britain. The trainer will go into more detail about how programmes can be specifically targeted at target groups including the technicalities of such an arrangement and how CESP was effectively implemented.

The final scheme example is the Energy Company Obligation (ECO). ECO is a government energy efficiency scheme in Great Britain which is designed to help reduce carbon emissions and tackle fuel poverty. The trainer will highlight and discuss ECO's three obligations:

1. Carbon Emissions Reduction Obligation
2. Carbon Saving Community Obligation
3. Home Heating Cost Reduction Obligation / Affordable Warmth

The trainer will go into detail about the actions suppliers must take in order to comply with the various obligations and highlight how such a scheme is likely to be highly replicable in other countries.

Finance / Loan Schemes

In Session 2-2 trainees will be introduced to finance and loan schemes that can assist those developing nZEBs. At the beginning of the session the trainer will give an overview of what the schemes are generally, who the target group is, a brief mention of the related product and technologies and the flexibility of such schemes.

The trainer will then discuss a number of Loan Schemes in further detail, using UK examples, including:

- District Heating loan scheme
- Small and medioum business loan scheme
- Home renewables loan scheme
- SALIX Finance – a low energy loan scheme for public bodies

Trainess will then be given further information on SALIX finance mechanisms. This will include a discussion of how SALIX loans operate – target group, criteria for application, etc. Following the concept of a Recycling Fund will be explained to trainees as well as give an example of a potential use of such a Fund e.g. to increase capital investment in energy efficient technologies across the public sector. Trainees will be given further indight into how schemes of this nature operates and their successes to date within the UK.

The trainer will then discuss other innovative green finance schemes including (i) innovative green finance schemes which enable energy efifiency and carbon reduction and (ii) schemes where installation costs are re-paid through energy savings. Learning will be reinforced via referecne by an example of each, namely (i) the (UK) Green Deal and (ii) the Energy Performance Contarcts (EnPC) / leaseback schemes.

Financial Incentive Schemes

In Session 2-3 trainees will be introduced to financial incentive / clean energy cashback schemes. The trainer will explain what these schemes are who the target group is, the types of products and technologies that such schemes typically consist of, and the incentives such schemes can provide. Following this overview the trainer will present different examples of schemes of this type that have been used or still being used in different countries to enforce the learning.

Attendees will be introduced to the UK's "Renewable Obligation" as a main support mechanisms for large-scale renewable electricity projects in the UK. The trainer will explain the requirements such as scheme places upon UK electricity suppliers to ensure they produce a certain proportion of electricity they supply from renewable sources. The related Renewable Obligation Certificates (ROC's) will be discussed and how the ROC trading system operates. Additionally, attendees will be introduced to how this scheme was amended to include provision for the 'Feed- in Tariff' (FIT) and the (world first) 'Renewable Heat Incentive' (RHI) schemes, which are schemes for renewable electricity generating technologies and renewable heat generating technologies respectively.

Tax Relief / Fuel Levy Relief Incentives

In session 2-4 trainees will be introduced to how tax relief and fuel levy relieve incentives and mechanisms can be used to help increase energy efficiency. The trainer will begin the session by explaining what these scheme are, how they typically work, who their target group is, and some of the common incentives. Learning will then be reinforced via examples of such financial mechanisms. The first example the trainer will present is a UK based tax relief scheme called the Enhanced Capital Allowance (ECA) which grants tax relief to companies investing in new energy efficient equipment. Attendees will be introduced to the qualifying criteria, categories, products included in the ECA scheme, and the Energy Technology Criteria List of qualifying technology to highlight how such a scheme has been structured. Attendees will also be introduced to fuel levy relieve incentive mechanisms predominantly through an example of one such UK based scheme called Climate Change Agreements (CCA). The trainer will explain how these voluntary agreements can be used to incentivise industry, building owners and other relevant organisations, to reduce energy use and carbon dioxide emissions. Trainees will also be introduced to the two different types of CCAs – umbrella agreements and underlying agreements, their differences and how they operate.

Learning outcomes

The outcomes from Session 2 will be as follows:

- Attendees will have developed knowledge and understanding of a wide range of funding schemes, mechanisms and incentives of particular relevance to nZEBs and low carbon building design and operation. Attendees will therefore be able to use this knowledge or apply awareness of these mechanisms within their own work; enabling them to make use of available schemes to reduce the impact of future developments, or enabling them to be instrumental in developing similar mechanisms in their own country, region or municipality.

4.6 Session 3: Local country specific mechanisms

Learning objective

- To introduce attendees to, and develop their understanding of, selected country-specific mechanisms that support low energy building design and operation and the development of nZEBs.
- To provide attendees with an overview of the structure, operation, benefits and risks of the schemes and mechanisms.

Learning outcomes

The outcomes from Session 3 will be as follows:

- Attendees will have developed knowledge and understanding of key funding schemes, mechanisms and incentives of particular relevance to nZEBs and low carbon building design and operation within their specific country. Attendees will therefore be able to use this knowledge or apply awareness of these mechanisms within their own work; enabling them to make use of available schemes to reduce the impact of future developments, or enabling them to be instrumental in developing similar mechanisms in their own country, region or municipality.

4.6 Session 6: Discussion

Learning objective

- To enable attendees to discuss openly with their peers and colleagues the relative impacts, operation, suitability, usefulness, opportunities, barriers, etc. of the range of measures introduced during the training; and discuss their application or development within the relevant target country.

Content

This session will consists of an open workshop / discussion session where the trainer will lead and facilitate discussions with attendees on the issues related to financial mechanisms, schemes and incentives for supporting low energy buildings and nZEBs.

Greece

Examples of the program: “Energy saving in house” in Greece
Examples of “Feed in tariff schemes” in Greece
Examples of “PV rooftop systems” in Greece
Examples of “Net metering” in Greece
Examples of “Recycling Fund”, Carbon Emissions Reduction Target (CERT), Community Energy Saving Programme (CESP), Energy Company Obligation), Green Deal, Energy Performance Contracts (EnPC) / leaseback schemes), renewable obligations and Enhanced Capital Allowance (ECA)) in other countries

Learning outcomes

- Attendees will develop a deeper understanding on the use, application and regulation of such schemes, mechanisms and incentives through group discussion; as well as their potential use or relevance in their target country.

5 RISK REGISTER

The following table sets out the risk register, setting out the anticipated risks, the risk level and the control measures to manage such risk.

Risk - description	Risk Level	Risk management action
Lack of delivery of training materials by partners and complexity of developing material suitable for each country).	High	BRE and the local country partner to combine material supplied in each country with master material to create four “local” versions of the course. Hold session on training courses at next partners meeting to resolve any issues; hold special tcfs for WP3 as required. Coordinator action as required.
Poor delivery of classroom training by target country partners and trainers	Medium	BRE can coach the partners in the target countries and the trainers through Q&A sessions by video conferencing in order to improve understanding and address frequently asked questions.
Poor pass rate	Low - Medium	BRE and the local country partner will monitor rates and amend course content to support areas where there are specific issues.
Excessive differences in local issues	Low	BRE will review local material and advise on changes as required.

6. REVIEW OF MODULE

ITEM	REVIEW	ACTION
Training Module	Module 10: Funding Mechanisms	
Does the subject matter match the training essay plan – explain reasons	Yes. However it is recommended to: - make clear the scope of the funding/incentives at the beginning of the document, inside introduction or purpose of training, i.e., countries or front runner countries, as it is foreseen in the proposal "The aim is to make sure that the decision makers that will follow the course will be able to design new funding/promotion schemes for nZEB for the South European participating countries (EL, CY, PT, IT)" - separate the information related with the learning audience and do not detail together the trainers and trainees' profile in this module, as we have different target audiences - clarify the assessment component of the structure, and if not related with the exam/certification, this component also need to be explained	Changes have been made to bring greater clarity
What, if any deficiencies do you identify – explain reasons	- It would be interesting also have some contextual details from outside Europe	
General quality assessment – please comment	The contents/materials are very well designed and structured and message is clear. But. it is critical to ensure that the national adaptation/preparation of all contents currently available with UK details will be developed with same quality standards in all front runner countries	National context sections have been added by partners in South countries.
Further comments	Please see comments added to the training essay plan, that should be considered/clarified	
Suggested actions for this module	It is important the lead partner, BRE, advise/monitor the national adaptation/development of contents to minimise the risk	
Please add comments on specific sections and slides here.	- The first slide must contain compulsory information about the project including the project number and disclaimer text (as for all of other modules) - Consider to include the learning objectives after the programme slide - In some slides it is missing some references to info graphs/ pictures (could be done by a final slide 'Credits' e.g. if some refer to the same source or are not clear any	Completed changes

	more)	