



# BUNG

Developing nearly zero energy building skills through game-based learning

Project n°2020-1-FR01-KA202-079997



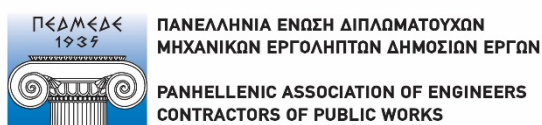
## 102- BUNG curricula



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## INTRODUCTION

Global demand for zero energy buildings has grown significantly over the last decade. The construction industry expects the trend to continue, given that zero-energy buildings contribute greatly to the shift to a more energy-efficient economy.

In light of this, the EU has adopted a number of legislative frameworks, plans, directives, and policies aimed at improving building energy performance such as the EPBD (Energy performance of buildings directive), the Green Deal and more.

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Focusing on nZEB buildings and the works needed to be completed in order to be structured, requires multidisciplinary work. Engineers, architects, construction strategists, construction managers, building counselors, and technical experts must work together. Consequently, it is necessary to identify the specific involvement of each profession in order to develop mutual understanding of each other's disciplines, obtain expert information on the skills required for the design and delivery of energy efficient buildings, and proceed to the identification of forward-looking skills in order to achieve optimal nZEB construction results.

The scarcity of green skills is already being recognized as a major bottleneck in industries that are closely associated with the nearly zero-energy building sector. The disparity between the rapid growth in demand for near-zero energy building skills in European labor markets and the slow growth in the number of vocational training programs available to meet those demands continues to exist in the European Union. However, despite the fact that training in nZEB skills has increased over the past few years, employers still have difficulty finding qualified employees to fill certain positions. For zero energy buildings, the primary reason for labor shortages is that skill requirements change as zero energy building technologies and practices are introduced or changed, resulting in previously satisfactory skill sets no longer being sufficient.

Upskilling of the construction sector in the nZEB sector will be addressed through the identification of best practices for adopting, implementing, and maintaining nZEB technologies, as well as by comparing the required nZEB skills with the current nZEB skills required in nZEB construction. A foundation for improving knowledge in the field of energy efficiency, as well as developing and implementing more efficient Vocational training policies in the nZEB sector, will be laid out by this study. A better understanding of current skills gaps and mismatches will aid in the identification of up-to-date competencies required to meet the growing demand for the construction of nearly zero energy buildings, as well as bridging the gap between construction vocational education and the energy efficiency labour market.

To this end, BUNG partners have proceeded to the following research activities aimed to develop an inventory that will comprise of the necessary green skills required for the design and delivery of energy efficient buildings:

- 1) Development and delivery of an inventory of existing occupational profiles and professional qualifications needed for the nZEB industry



2) Development of an inventory of available training and educational programmes in the nZEB sector

This document lists all the learning outcomes defined for the 6 areas covered in the BUNG learning game:

- Heating, Ventilation and Air Conditioning (HVAC) and lighting: Mechanical Ventilation with Heat Recovery (MVHR)
- Heating, Ventilation and Air Conditioning (HVAC) and lighting: Heating and Cooling
- Heating, Ventilation and Air Conditioning (HVAC) and lighting: Lighting
- Building Envelope (Thermal insulation, thermal bridges, highly efficient windows)
- Energy performance certificate
- Project Finance

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**Learning outcomes** are clear and concise statements that describe what learners will gain from a particular learning activity, be it a training session, seminar, course, or program. These outcomes are measurable and provide a way to assess the learner's understanding and progress. By focusing on the specific knowledge, skills, or expertise that will be acquired, learning outcomes help learners recognize the significance of the information and the benefits they can expect from their participation in the learning activity.

In this project the learning outcomes are divided into:

- **Knowledge:** it refers to the specific information, facts, concepts, theories, or principles that learners will acquire through the learning activity. It includes understanding and comprehension of subject matter or content
- **Skills:** It focuses on the abilities and practical application of knowledge that learners will develop. Skills involve the capacity to perform specific tasks or activities, often through practice and hands-on experience
- **Competences:** It emphasizes the overall capacity, capability, or proficiency that learners will possess in a particular area. Competences are broader than skills and encompass a combination of knowledge, skills, attitudes, and behaviors

In addition, the learning outcomes have been defined according to the European Qualification Framework. It is a common reference framework used across Europe to describe and compare qualifications and their levels of knowledge, skills, and competences. The EQF provides a common language and a transparent way of understanding qualifications, promoting their recognition and comparability within and between countries.

The EQF consists of eight levels, ranging from Level 1 (basic skills and knowledge) to Level 8 (highly specialized skills and knowledge). Each level is defined by a set of descriptors that outline the expected learning outcomes and the complexity of qualifications at that level.



The framework is based on the principle of learning outcomes, emphasizing what an individual knows, understands, and is able to do upon completion of a qualification, rather than focusing solely on the duration or method of learning.

The EQF facilitates the recognition of qualifications across different education and training systems, promoting mobility and transferability of qualifications within Europe. It enables individuals to understand and compare different qualifications, helping them make informed decisions about further education, training, or employment opportunities.

The EQF has been adopted by many European countries and is used to align national qualifications frameworks with the overarching European framework, creating a more cohesive and transparent system for assessing and recognizing qualifications.

In this project, the learning outcomes have been defined according the EQF level 5. EQF level 5 qualifications are characterized by intermediate skills and knowledge. They typically require learners to have completed secondary education or have a similar level of education and provide them with the competence to work independently in a specific field or undertake further education.

### EQF LEVEL 5

KNOWLEDGE	SKILLS	RESPONSIBILITY AND AUTONOMY
Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop performance of self and others

Source: [Europass](#)



## FIELDS OF APPLICATION

The areas were distributed within the partnership as follows:

- Project Finance - **SCVAP**
- Building envelope - **PETRA PATRIMONIA CORSICA**
- Heating, Ventilation and Air Conditioning (HVAC) - **BZB**
- Lighting - **GSZ**
- Energy performance certificate - **PEDMEDE and SOCIAL MIND**

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## LEARNING OUTCOMES

Heating, Ventilation and Air Conditioning (HVAC) and lighting: Mechanical Ventilation with Heat Recovery (MVHR) – EQF 5

KNOWLEDGE	SKILLS	COMPETENCES
Knowledge on facts, principles, processes and general concepts on the role of mechanical ventilation in maintaining high quality indoor air, with special regard for appropriate levels of CO2 as well as relative humidity	Design in detail a full whole-house ventilation system including specification of all key components	Management and supervision related to commissioning specialist components in the MVHR system including fire dampers, CAR dampers (constant air-flow), iris dampers, frost protection systems (pre-heaters), post-heaters, summer bypass systems, pressure differential switches (used to ramp-up ventilation rates where flow rates are curtailed by, for example, dirty filters), make-up air dampers (required for commercial-style kitchen extracts and commercial dryers) and CO2 and humidity sensors used to regulate air-flow and operate 'slave dampers'
Knowledge on facts, principles, processes and general concepts on designing appropriate air flow rates (both supply and extract) for a residential project	Appropriately dimension duct sizes (cross-sectional areas) to minimise pressure losses whilst maintaining modest air speeds to reduce risk of irritating noise for occupants	Management and supervision related to ensuring that the MVHR system proactively contributes towards comfortable indoor temperatures and relative humidity in warmer climates - Management and supervision related to measuring noise levels of ventilation system in order to





		ensure compliance with recommendations for different room occupancy types
Knowledge on facts, principles, processes and general concepts on cascade ventilation and the need for air to transition from supply room to extract rooms	Select an appropriate MVHR unit for the project considering the key objectives to (a) delivering the required air flow rates, (b) maximising heat recovery rates, (c) minimising electrical fan power required	
Knowledge on facts, principles, processes and general concepts on the principles of heat transfer in a Mechanical Ventilation with Heat Recovery unit and the pros and cons of using an Energy Recovery Ventilators in terms of humidity transfer in both very cold and very humid climates	Size appropriately the transfer openings required in order to minimise pressure drops	
Knowledge on facts, principles, processes and general concepts on the relationship between temperature, absolute humidity and relative humidity and appreciation that excessive ventilation in cold weather can result in low indoor relative humidity	Evaluate the pros and cons of using centralised versus decentralised ventilation approach for multi-family buildings	
Specialised knowledge on emerging technologies and research innovation in Mechanical Ventilation with Heat Recovery systems for high performance residential projects	Measure pressure drops and ability to introduce dampers to the system to regulate and adjust air flow as required	
Specialised knowledge on indoor air quality parameters and management of those indicators using mechanical ventilation systems	Calculate the likely indoor relative humidity in a given climate given system flow rates, outdoor air design temperatures and average indoor moisture generation	
	Model and simulate using specialist software the air flow paths and air mixing resulting from different positioning of supply and extract air registers with a view of optimal positioning as well as	



**specification of grill-type and to avoid short-circuiting of air flow**





## Heating, Ventilation and Air Conditioning (HVAC) and lighting: Heating and Cooling – EQF 5

KNOWLEDGE	SKILLS	COMPETENCES
Knowledge on both latent and sensible cooling, including ability to interpret a psychrometric chart	Interpret the performance specifications of and test data for heating and cooling equipment (including reference to exterior temperatures) in order to determine their ecoefficiency of performance (COP) and to ensure selection of optimal equipment for the climate	Management and supervision related to the selection of the most optimal heating and cooling system for a project considering the available services (electricity, gas, wood, oil) and costs
Knowledge on the sizing of heating and cooling systems	Design a heating and cooling system including the generation and distribution system (whether hydronic or air-based) as well as placement and sizing of emitters	Management and supervision related to commissioning of heating and cooling equipment and systems including initial programming (time, temperature, daily operational times) in accordance with the habits of the homeowner
Knowledge on different heating and cooling systems such as boilers, heat pumps, mini-split systems and district heating	Integrate the heating and cooling system into the fresh air (mechanical ventilation with heat recovery) system	Management and supervision related to integration of the heating system with the domestic hot water system and solar system (where used)
Knowledge on appropriate sizing of heating and cooling circulation pipes as well as circulation pumps	Calculate the heat loss through pipework as determined by temperature flow, pipe diameter and insulation type and thickness	Management and supervision related to use thermographic imagery for the purposes of verifying and commissioning the continuity of insulation on all pipework
Knowledge on dimensioning of pipework insulation thickness and quantitative understanding of the performance of different insulation types		Management and supervision related to correct placement of supply air registers in living spaces to optimize the distribution of heat when distributed via the MVHR
Knowledge on 'risk rooms' where excessive heat gain or heat losses might occur and where supplementary cooling and / or heating might be required		

## Heating, Ventilation and Air Conditioning (HVAC) and lighting: Lighting – EQF 5

KNOWLEDGE	SKILLS	COMPETENCES
<b>LEARNING OBJECTIVES:</b> <b>Daylighting Principles and Strategies for Sustainable Design</b>	<b>Able to make a proposal for lighting design for various living spaces based on the availability of natural daylight as well as room function and lux levels</b>	<b>Ability to make recommendations for space allocation in residential buildings in a specific, known location</b>
<b>Daylighting is the controlled admission of natural light through windows into a space to reduce or eliminate electric lighting. By directly connecting to the dynamic and ever-changing outdoor lighting conditions, daylighting helps create a visually stimulating and productive environment for a building's occupants while reducing up to one-third of a building's total energy costs. An overview of daylighting principles and other topics that support effective daylighting design, such as electric lighting controls, solar shading, and shading devices. Understand the benefits of effective daylighting</b>	<b>Able to solve complex and unpredictable problems related to energy-efficient lighting design</b>	<b>Understanding of the needs of residential users when planning lighting</b>
<b>Describe methods of construction that support effective daylighting design</b>	<b>Understands the process and goals of a lighting project</b>	<b>Awareness of the hazards posed by improperly designed lighting systems that do not meet safety codes</b>
<b>Summarize at least one daylighting design strategy upon reviewing an example</b>	<b>Can estimate the time period of the preparation and implementation process</b>	<b>Understanding of lighting systems and their operating principles</b>
<b>List the types of electric lighting controls</b>	<b>Conceptual design of lighting</b>	<b>Correct execution of measurements with lighting measuring instruments</b>
<b>Describe how sun control and shading devices support an effective daylighting strategy</b>	<b>Lighting project</b>	
<b>List at least one daylighting requirement by law</b>	<b>Lighting implementation</b>	

**LEARNING OBJECTIVES:  
Advanced Lighting Systems:  
An Overview (for residential  
buildings)**

A comprehensive overview of lighting systems, including light sources, lighting controls, and types of LED technologies, and identifies cost-effective LED applications

Identify various lighting types and their key applications

Evaluate key factors in LED retrofit and replacement

Select proper lighting control configurations; and

Choose cost-effective LED products

**Learning Objectives  
Adopting LED Technology**

The basics of LED technology, including its strengths and weaknesses

The specifics of LED attributes compared with other lighting technologies

LED economic considerations

How to perform cost-effectiveness evaluations; and

Specific LED product application considerations

Managing lighting wastes

**Learning Objectives  
Advanced Exterior Lighting  
Systems**



Identify various types of exterior lighting sources and their applications

Select proper lighting controls for exterior lighting systems

Comply with legislation exterior lighting configuration requirements

Determine energy savings opportunities in exterior lighting systems

**Learning Objectives**  
Advanced Interior Lighting Systems (for residential buildings)

Applications of indoor lighting systems, including types of technologies, lighting controls, savings opportunities, and emerging technologies and trends for indoor lighting

Identify various interior lighting source features and applications

Select proper lighting controls for interior lighting system

Determine energy savings measures for interior lighting systems

**Learning Objectives**  
Glossary on units of measure in lighting

Lux, lumens and watts

Standard for light intensity

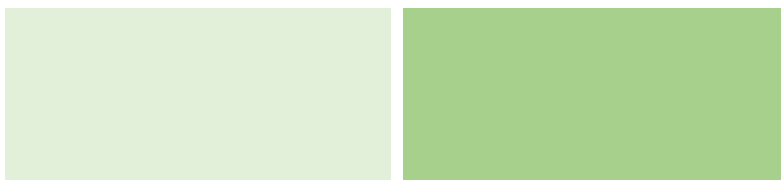
Calculation of the number of lumens

**Learning Objectives**  
Ergonomic Lighting Levels by Room for Residential Spaces



(Standard for light intensity in residential buildings)

Room Lighting Levels



## Building Envelope (Thermal insulation, thermal bridges, highly efficient windows) – EQF 5

KNOWLEDGE	SKILLS	COMPETENCES
Knowledge on concepts of health and safety issues regarding the installation of thermal insulation	Generate solutions to specific problems related to installation of thermal insulation on different types of building elements and different types of systems on the market	Management and supervision within the guidelines of work related to installation of thermal insulation on different types of building elements and different types of systems on the market
Knowledge on the principle of the unbroken thermal envelope (external, internal insulation; diffusion-impermeable and diffusion-permeable solutions)	Generate solutions to specific problems related to the issues of quality control process	Review and develop performance of self and others, taking some responsibility for the evaluation and improvement of work (related to cross-crafting issues)
Knowledge on the insulating materials and their properties - the overview of products available on the market; requirements and possibilities, including advantages and disadvantages	Generate solutions to specific problems related to risks and construction damage resulted from installation mistakes	Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work related to thermal insulation of new and existing buildings
Knowledge on hygrothermal and physical properties of materials (thermal conductivity, water vapor diffusion resistance factor, reaction to fire, etc.) as characteristic values	Generate solutions to specific problems related to the concepts of cross-crafting	Manage and transform complex work on the design and/or installation of thermal insulation
Knowledge regarding building elements	Identify interactions within the thermal envelope as relevant regarding thermal bridging	
Knowledge regarding properties of elements comprising building envelope (U-values, water vapour resistance, fire behaviour of different kind of building envelopes, noise protection, etc.)	Execute an assessment of condensation risk analysis in thermal bridges	Identification and qualification of thermal bridges in drawings and buildings under guided supervision
Knowledge on correct installation of insulation materials	Carry out a comprehensive analysis of thermal bridge performance	Perform an analysis of thermal bridge performance during the design and/or construction process

Knowledge on risks and construction damage resulted from installation mistakes	Interpret and solve problems arising from the legislative framework, codes and standards appropriate to the thermal bridging	Review performance of others when using materials or details which might lead to creating or worsening a thermal bridge
Knowledge on quality control of thermal insulation	Use thermographic technology and other diagnostic technology to verify the successful treatment of thermal bridges	Identification, quantification and minimization of thermal bridges in drawings and buildings
Knowledge on the durability and pathology of insulating materials	Install windows in the correct position in the thermal envelope, ensuring continuity with the insulation layer	Identification of appropriate and high-quality window as well as optimised installation in drawings and buildings
Knowledge on cross-crafting with critical awareness of knowledge issues at the interface between different fields	Ensure that each window is fitted in the correct location, bearing in mind that windows of similar sizes may have different solar heat gain coefficient values which will not be apparent without reading the window labels	Sketch of suitable window installation detail (for different construction types) for optimised performance
Knowledge on the classification and types of thermal bridges	Achieve suitable connection of the window to the airtight layer using appropriate materials	
Knowledge on the surface temperatures at thermal bridges	Adjust windows during airtightness testing to ensure minimal leakage	
Knowledge on moisture related building damage due to thermal bridges	Develop design solutions of suitable window installation detail (for different construction types) for optimised performance	
Knowledge on the influence of thermal bridges on the heat losses		
Knowledge on fundamental rules for prevention of thermal bridges		
Knowledge on fundamental strategies to minimise thermal bridging where avoiding them is not entirely possible		
Knowledge on thermal bridge optimised window installation		





Knowledge on quality assured products available to avoid or minimise thermal bridging

Knowledge on facts, principles, processes and general concepts of cross-crafting

Knowledge on all the limitations and assumptions regarding the thermal bridging

Knowledge on quantification of thermal bridges ( $\psi$  and  $\chi$  values)

Knowledge on thermal conductivities of various building materials that can cause thermal bridging

Knowledge on legislative framework, codes and standards related to thermal bridges

Knowledge on function of windows in general, and in relation to the energy efficiency and comfort: view towards the outside, thermal protection, solar gains, ventilation during day and during night

Knowledge on the requirements for windows in general: airtight, thermally insulating (U-value), transparent, possibility for opening and providing shade, when necessary, installed in a thermal bridge minimised/free manner, installed in an airtight manner

Knowledge on glazing and glazing edge, overview of requirements, g-value

Knowledge on the qualitative energy balance of a window





## Energy performance certificate – EQF 5

KNOWLEDGE	SKILLS	COMPETENCES
knowledge of environmental regulations affecting building system design and occupancy health and safety in connection to the building ecology, ecology of building materials and sustainability in reference to the national and international building codes	Describe main safety requirements in buildings and renovation process and relate to key regulation and responsible specialists	Management and supervision within the guidelines of work related to health and safety regulations at work.
knowledge of EU legislation relevant to energy efficiency policy (Directive 2012/27/EU, EPBD, EcoDesign)	Describe the technical, regulatory and regulations related to occupancy health and safety in renovation process, including specific requirements involving hazardous materials in buildings	Provision of consultancy on existing support programmes for nZEB renovations
knowledge of legislative proposal “Clean Energy for all Europeans” (Winter package)	Identify EU legislation acts related to energy efficiency and explain their main goals	Read and understand the results of energy audits and energy performance certificates of buildings.
knowledge of national energy efficiency action plan	Understand requirements of national programmes supporting energy efficient renovations	Performing calculations related to energy performance certificate or to energy audit.
knowledge of energy performance certificates and energy audits requirements.	Read and understand energy performance certificate of building	Communication with technical and non-technical decision-makers.
knowledge of required parameters of building materials, types of buildings, required parameters of building structures, renovation technologies.	Understand the principles of issuing energy performance certificate and its results	Understanding and application of energy audit principles and methodologies.
knowledge of energy use in buildings and building physics, including thermal balance calculation	Understand the results and recommendations of energy audits of the buildings	Issuing energy performance certificate and /or energy audit of the building/ group of buildings.
knowledge of required parameters of HVAC systems related to achievement of nZEB standard	List and describe main national programmes supporting energy efficient renovations	Capacity of assess energy performance improvement measures within energy advising or energy audit.

knowledge of Local implementing decrees	Read and understand details of energy performance certificate calculations	
knowledge of related software tools	Apply software tools to issue energy performance certificate of building or to elaboration of energy audit.	
knowledge of Nationally recognized tools	Perform calculations for issuing energy performance certificate of building	
knowledge of BIM tools	Understand and design/implementation of selected solutions for fulfilment of required parameters of building components and systems	
knowledge on principles of building ecology and ecology of building materials (incl. recycling and reusing); methods for the description and evaluation of ecological performance of building elements, components, systems, and structures including emissions of greenhouse gases and air pollutant; the application of LCA (Life-Cycle Assessment) and EIA (Environmental Impact Analysis) techniques in nZEB standard		
knowledge on current research on climate change issues, CO <sub>2</sub> and energy saving potential of the building stock		



## Project Finance – EQF 5

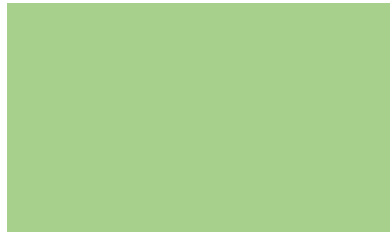
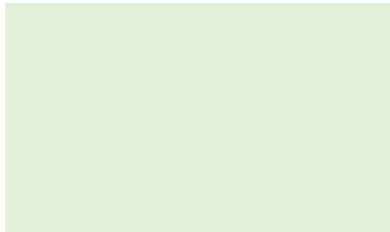
KNOWLEDGE	SKILLS	COMPETENCES
Knowledge of definition of cost-effectiveness	Define cost effectiveness	Management and supervision for reading the budget properly with regard to cost effectiveness
Knowledge on existing methods to assess cost-effectiveness of renovation project	Understand the results of cost effectiveness assessment	Management and supervision for choosing building material with optimal cost effectiveness
Knowledge on the current energy prices	Understand the difference between investment costs and energy saving costs	Management and supervision for implementing recommended cost-effective measures
Knowledge on sustainable economic development with reference to buildings, long-term benefits of nZEBs	Identify the factors that may positively influence the economic efficiency of a building	Management and supervision for estimating the budget of nZEB constructions
Knowledge on costs over the service life of a nZEB building compared with a usual building, assuming an average price of energy for the period considered, the residual value of a building at the end of the period under consideration	Understand the relationship between capital costs and costs relating to all types of energy saving measures	Management and supervision within the identification of the necessary steps in drawings and buildings and estimation of their suitability / economic efficiency / comfort benefits and impact
Knowledge on general costs and costs related to energy saving measures	Apply LCA methods	Autonomously developing a complete Step-by-step retrofit plan and a basic financial analysis within an LCA
Knowledge on economic efficiency of the individual measures	Understand the economic efficiency based on current costs	Management and supervision within the guidelines of work related to the plan implementation, time-schedule and task distribution
Knowledge on economic efficiency of a package of measures	Compare investment costs to gains from energy savings	Management and supervision for processing project documents with responsibility and autonomy
Knowledge on documentation on investment and operational costs	Understand the benefits of building and renovating according to nZEB energy efficiency standards	Management and supervision for monitoring: project status, technical state of the building, energy consumption of the building



Knowledge on potential for energy savings in reference to the national and international renovation standards	Understand the economic efficiency of the different steps within a life-cycle assessment	Management and supervision for processing statistical data for making decisions about project and management strategies
Knowledge on multiple benefits and accountability to different stakeholders	Identify opportunities for energy savings	Management and supervision for reading, processing and creating project documents and project management strategies
Knowledge on Commissioning / Facility Management / Monitoring	Use statistical data for monitoring state of project and process energy statistics	Management and supervision for decisions on energy management system and project management activities
Knowledge on economic efficiency of the different steps; Life-cycle assessment; Sensitivity analysis; Financial analysis	Use related software tools for project and energy management	Management and supervision for planning and monitoring project activities
Knowledge on financing tools and support schemes	Use of software tools to evaluate operational states by comparing actual and required parameters of energy use in buildings	Management and supervision for results of multicriteria assessments
Knowledge on national legislation related to project management		Management and supervision for application of specialised software for managing and collecting data for project and energy management
knowledge on definition and principles of project management and energy management		Management and supervision for fulfilment of requirements of national energy efficiency legislation
Knowledge on use of specialised software for managing and collecting data for project and energy management		Management and supervision for guiding the planning to achieving certain certification standards
Knowledge on project financing: (a) financial decision-making processes; (b) economics of energy management (c) incomes and outcomes of the project		
Knowledge on efficient use of energy in buildings, operation and maintenance practices and requirements		

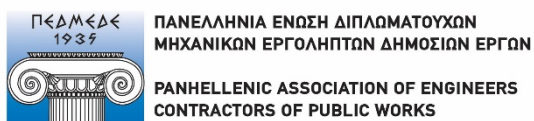


knowledge on main principles of sustainability in relation to NZeb buildings: Social, economic and environmental factors and their interrelation and influence on the project





# BUNG



**BZB**

**Bildungszentren des  
Baugewerbes e.V.**



Chamber of Construction  
and Building Materials Industry  
of Slovenia



**Social-  
mind**



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