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D 2.5. Overview of pathways of integration of previous EU project resources report

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Produced by	Anna Moreno
Main author	Anna Moreno,
Co-authors	Emanuele Mignone, Lorenzo Nissim
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Publishable executive summary

A deep analysis of the directives on the dissemination of renewable energies, the energy efficiency/performance of buildings and European directive for the introduction of Building Information Modelling in the public sector reveals that they have been transposed into national laws in all the countries and partially in North Macedonia, although their implementation is different in each country. In particular, the articles related to the qualification and/or certification of the workforce have been implemented differently.

The BUILD UP SKILLS initiative has allowed many European partnerships to develop qualification systems and training materials that could be used to help all the European countries to have a platform to develop and recognize the competences needed to have both new and existing buildings at zero energy. In this document we identify what is the gap to cover and the outcome of which project could be used to fill the gap in the competences needed. All the projects of BIM EPA have been considered. Besides, the CEN Workshop Agreement CWA 17939, promoted by Train4sustain project, has been compared with BIM EPA outcomes to have a widely accepted description of competences not included in any technical annex of the European directives.

Some of the competences listed in CWA 17939 are outside the scope of the ARISE project but, as they are related in general to buildings' performance, have been considered in this report. Furthermore, even if there is a separate chapter for digital competences, it has been considered useful to add digital competences to each of the competences described in the other paragraphs as digitalization is a new tool that anybody, in the building industry, should learn how to use properly.

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1. Acronyms

AI: Artificial Intelligence
bSDD: buildingSMART Data Dictionary
BIM: Building Information Model
BIM-EPA: BIM and Energy Performance Alliance
CA: Concerted Action
EE: Energy Efficiency
EPB: Energy Performance of Buildings
IoT: Internet of things
LCA: Life Cycle Analysis
LCC: Life Cycle Costing
MS: Member State
NGOs: Non-Governmental Organisations
nZEB: Nearly Zero-Energy Buildings
R&D: Research and Development
RES: Renewable Energy Source
RoI: Return on Investment
SME: Small and Medium-size Enterprise

2. Introduction

The deliverable 2.4 has provided evidence of the different approaches towards the directives' implementation in the different countries. Ireland and the Netherlands seem to have a more organised system to register the qualified workers, but most European countries are in a different situation. In Italy, for instance, the qualifications are managed at regional level (20 regions) and, in most cases, only the VET providers have a register of the qualified workers. The same is for professionals such as engineers, architects, surveyors, technical experts, etc. as they are organised at provincial level and in Italy there are 92 provinces!!. Each of them manages the CPD (Continuing Professional Development) and they do not have any register specific, for instance, of experts in the design and construction of photovoltaic plants, building automation systems, building information modelling, etc. This makes it impossible, for any customer, to establish in advance if the workforce that is going to design and build or refurbish the property has the right competences.

Therefore, in this report, we start from the implementation of directives discussed in the deliverable D2.4 First overview of other EU wide certification schemes report and merge this with information about what has been done in the European projects considered in the BIM EPA alliance and others.

This comparison is necessary to have the baseline for the roadmap which is the object of ARISE deliverable 2.8: European roadmap BIM applied to energy performance improvement report.

In the tables of the next paragraphs, we examine the requirements of the Directives already considered in D2.4 "First overview of other EU wide certification schemes report" and we compare these requirements with the content already developed within the BIM EPA network or other European funded projects. In the following sub paragraph, we indicate if the directive is really implemented in each ARISE member country and add some comments when needed.

A column is added to describe the digital competences that any worker and/or professional should possess to perform any activity in any stage of the building process. In the last table the basic digital competences are listed in a separate table, and they refer to the one that have been identified by the international community of buildingSMART.

3. Directive on the promotion of the use of energy from renewable sources"

In the following table the single technologies mentioned in the RES directive are reported as they were described in the technical annex and are compared with the competences already developed in the EPA network projects. A column with the digital competences has been added.

3.1. Solar power systems for electricity generation

Project phase	Short description	Detailed description of competencies	Source	Requirement for the legislation	Digital requirements
General	Understand PV systems in relation to NZEB	Understands the basic working and application of PV systems, is able to explain and take part in discussions. Is familiar with different types (e.g. panels, roofs). Understands the influence of external aspects e.g. orientation, shadowing on the performance.	BIM-EPA	The ability to determine the required installation area, orientation and tilt for the solar photovoltaic, taking account of shading, solar access, structural integrity, the appropriateness of the installation for the building or the climate and identify different installation methods suitable for roof types and the balance of system equipment required for the installation;	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use simulation tools to identify the best layout of the plant. Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Use clash detection to solve interferences among the different designs
Preparation	Perform a feasibility study on Photovoltaic systems	Can perform a feasibility study including financial aspects, the use of batteries and discuss the outcomes. Has knowledge of different types of PV systems, quality aspects, energy efficiency.	BIM-EPA	The ability to identify systems and their components specific to active and passive systems, including the mechanical design, and determine the components' location and system layout and configuration;	Use BIM 4D and 5D software to evaluate the costs and the time for the intervention. Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements Know how to use openBIM software tools to design the plant.

Design	Engineer a PV system	Can engineer and calculate the needed PV energy (m2, Wp/m2, colour , frame work). Understands basic principles needed in design and calculation, e.g. orientation, Wp, Wp/m2, power inverter. Knowledge and understanding of batteries to store power generated with PV cells. Can determine construction boundaries e.g. needed space, weight. Engineering of the electrical components e.g. power inverter and batteries	BIM-EPA	The ability to adapt the electrical design, including determining design currents, selecting appropriate conductor types and ratings for each electrical circuit, determining appropriate size, ratings and locations for all associated equipment and subsystems and selecting an appropriate interconnection point, related subsidies	Know how to use simulation software to evaluate the right thermal and electric load during the year. Use clash detection to solve interferences among the different designs. Know how to use openBIM software tools to design the plant. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Construction	Specify a PV system in tender documents	Is able to select products that fit specifications and demands on given quality aspects. Make detailed descriptions and drawings of the design. Is able to make financial calculations related to contracting phase	BIM-EPA	Overview of the market situation of solar products, cost and profitability comparisons, components, characteristics and dimensioning of solar systems, selection of accurate systems and dimensioning of components, knowledge of any European standards for technology, and certification such as Solar Keymark, related national and Community law	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant. Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant.
Construction	Quality assurance on realisation of PV systems	Can manage, instruct and audit contractors on site during realisation of a PV system, based on information given by the designer and the tender documents. Is able to instruct the contractor on the specifics of the system. Can audit the realisation on critical points.	BIM-EPA	Design, installation, and maintenance of solar photovoltaic,	Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised. Know how to organize the ordinary and predictive maintenance based on the information received during the handover
Construction	Commission a PV system	Can commission a PV installation on functionality. Can determine if the installation operates as planned, makes sure the foreseen energy performance is realised.	BIM-EPA	The ability to work safely using the required tools and equipment and implementing safety codes and standards and identify plumbing, electrical and other hazards associated with solar installations;	Know how to use AI systems to train the facility manager and on field operators.

In use	Ensure optimal operation of PV during life cycle	Can give instructions to users (or to facility manager). Is able to set up a maintenance plan	BIM-EPA	Maintenance of solar photovoltaic	Know how to read the BIM model and update it after each maintenance intervention.

3.2. Solar thermal energy installation

Project phase	Short description	Detailed description of competencies	Source	Requirement for the legislation	Digital requirements
General	Understand solar heating systems	Has general knowledge on solar thermal energy systems by heat tube collectors. Understands the basic working, is aware of boundary conditions. Is able to discuss within the project team.	BIM-EPA	The ability to determine the required installation area, orientation, and tilt for the solar water heater, taking account of shading, solar access, structural integrity, the appropriateness of the installation for the building or the climate and identify different installation methods suitable for roof types and the balance of system equipment required for the installation;	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant.
Preparation	Perform a feasibility study on solar heating systems	Can perform a feasibility study and calculate available solar energy. Can estimate the heat loss of the building and heating demand. Can determine the demands of domestic hot water (average, peak demand). Can estimate the needed storage volume and possible types of storage tanks. Understands the interaction between water storage / peak demand / available solar energy / external heating	BIM-EPA	The ability to identify systems and their components specific to active and passive systems, including the mechanical design, and determine the components' location and system layout and configuration;	Use BIM 4D and 5D software to evaluate the costs and the time for the intervention. Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements Know how to use openBIM software tools to design the plant.

		when lack of sunshine. Can determine needed external heating system.			Use clash detection to solve interferences among the different designs
Design	Engineer a solar heating system	Can engineer a solar thermal energy system. Calculate accurate heating demand of the building, calculate accurate domestic hot water demand in order to select the right capacity (kW, litres). Can make a detailed design of the installation, principle, automatization strategy, using available products and concepts. Can determine and calculate external heating.	BIM-EPA	The ability to determine appropriate size, ratings and locations for all associated equipment and subsystems and select an appropriate interconnection point, related subsidies	Know how to use simulation software to evaluate the right thermal and electric load during the year. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Construction	Specify a solar heating system in tender contracts	Can specify solar heating installations in tender documents. Can make detailed descriptions and drawings and select fitted products. Is able to make financial calculations related to contracting phase	BIM-EPA	Overview of the market situation of solar products, cost and profitability comparisons, components, characteristics and dimensioning of solar systems, selection of accurate systems and dimensioning of components, knowledge of any European standards for technology, and certification such as Solar Keymark, related national and Community law	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant. Know how to use the BIM Collaboration Format to underline and solve any issue during the construction.
Construction	Quality assurance of realisation of solar heating systems.	Can manage, instruct and audit contractors on site during realisation of a solar heating system, based on information given by the designer and the tender documents. Is able to instruct the contractor on the specifics of the system. Can audit the realisation of critical points.	BIM-EPA	Design, installation, and maintenance of solar thermal installations.	Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised. Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant.
Construction	Commission a solar heating system	Can commission a solar heating installation on functionality in all seasons, under full and partial load, seasonal performance. Can determine if the installation operates as planned, makes sure the foreseen energy performance is realised.	BIM-EPA	The ability to work safely using the required tools and equipment and implementing safety codes and standards and identify plumbing, electrical and other hazards associated with solar installations.	Know how to use AI systems to train the facility manager and on field operators.

In use	Ensure optimal operation of solar heating system	Monitor and control the solar heating installation on critical parameters, in order to guarantee the designed performance during life cycle. Can design a maintenance plan.	BIM-EPA	Maintenance of solar thermal installations	Know how to manage the monitoring system through the BIM model and intervene when needed. Know how to read the BIM model and update it after each maintenance intervention.
In use	Communicate the appropriate use and maintenance of the solar heating system	Can instruct the facility manager on monitoring parameters, to guarantee that the system achieves the designed energy saving goals	BIM-EPA	Maintenance of solar thermal installations	Know how to read the information related to the thermal and electric load during the year and intervene if they compromise the comfort of the inhabitants. Know how to read the BIM model and update it after each maintenance intervention.

3.3. Heat pump installation

Project phase	Short description	Detailed description of competencies	Source	Requirement for the legislation	Digital requirements
General	Understand heat pumps in relation to energy performance	General knowledge of heat pumps, design and application. Is aware of the specific need for a low temperature energy source. Can take part in discussions in the design team.	BIM-EPA	Knowledge of any European standards for heat pumps, and of relevant national and Community law. basic understanding of the physical and operation principles of a heat pump, including characteristics of the heat pump circle: context between low temperatures of the heat sink, high temperatures of the heat source, and the efficiency of the system, determination of the coefficient of performance (COP) and seasonal performance factor (SPF), understanding of the components and their function within a heat pump circle, including the compressor, expansion valve, evaporator, condenser, fixtures and fittings, lubricating oil, refrigerant, superheating and subcooling and cooling possibilities with heat pumps	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation.

					Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences
Preparation	Identify and select fitted heat source for use with heat pumps	Can determine available heat/energy sources. Is aware of types of available heat sources for use with heat pumps, understands the influence of source temperature on energy efficiency.	BIM-EPA	Geothermal resources and ground source temperatures of different regions, soil and rock identification for thermal conductivity, regulations on using geothermal resources	Use BIM 4D and 5D software to evaluate the costs and the time for the intervention.
Preparation	Perform a feasibility study on heat pump installations	Can perform a feasibility study on what type of heat pump fits the demands, including financial aspects, weighting and balancing of components that are needed in relation to energy saving.	BIM-EPA	Feasibility of using heat pumps in buildings and determining the most suitable heat pump system, and knowledge about their technical requirements, safety, air filtering, connection with the heat source and system layout	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements Know how to use openBIM software tools to design the plant. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc.
Design	Engineer standard heat pump installations	Can engineer a (standard) heat pump system, including calculations of heat loss (transmission), needed capacity, mono- or bivalent, energy balances (e.g. important when using geothermal energy), noise reduction.	BIM-EPA	Ability to choose and size the components in typical installation situations, including determining the typical values of the heat load of different buildings and for hot water production based on energy consumption, determining the capacity of the heat pump on the heat load for hot water production, on the storage mass of the building and on interruptible	Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis. Know how to use simulation software to evaluate the right thermal and electric load during the year

				current supply; determine buffer tank component and its volume and integration of a second heating system	
Design	Engineer complex and innovative heat pump installations	Can engineer a complex heat pump system, using innovative products, alternative heat sources etc. Can make detailed drawings and hydraulic schemes that determine it's functionality. Can describe the automatization strategies.	BIM-EPA	Ability to choose and size the components in typical installation situations, including determining the typical values of the heat load of different buildings and for hot water production based on energy consumption, determining the capacity of the heat pump on the heat load for hot water production, on the storage mass of the building and on interruptible current supply; determine buffer tank component and its volume and integration of a second heating system	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Construction	Specify heat pump installations in tender contracts	Can specify heat pump installations in tender documents. Can make detailed descriptions and drawings and select fitted products.	BIM-EPA	Overview of the market situation for heat pumps	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant
Construction	Quality assurance of heat pump systems during realisation	Can manage, instruct and audit contractors on site during realisation of a heat pump system, based on information given by the designer and the tender documents.	BIM-EPA	Feasibility of using heat pumps in buildings and determining the most suitable heat pump system, and knowledge about their technical requirements, safety, air filtering, connection with the heat source and system layout	Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised. Know how to use the BIM Collaboration Format to underline and solve any issue during the construction. Know how to organize the handover and deliver the information to the asset manager
Construction	Commission a heat pump installation	Can commission a heat pump installation on functionality in all seasons, under full and partial load, seasonal performance. Can determine if the installation operates as planned, makes sure the foreseen energy performance is realised.	BIM-EPA	Feasibility of using heat pumps in buildings and determining the most suitable heat pump system, and knowledge about their technical requirements, safety, air filtering, connection with the heat source and system layout	Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised.

					Know how to use the BIM Collaboration Format to underline and solve any issue during the construction. Know how to organize the handover and deliver the information to the asset manager. Know how to use AI systems to train the facility manager and on field operators.
In use	Ensure optimal operation of heat pump installations	Can design a maintenance plan and instruct the facility manager on monitoring parameters, to guarantee that the system achieves the designed energy saving goals	BIM-EPA	Feasibility of using heat pumps in buildings and determining the most suitable heat pump system, and knowledge about their technical requirements, safety, air filtering, connection with the heat source and system layout	Know how to read the BIM model and update it after each maintenance intervention. Know how to collect information for extraordinary maintenance. Know how to use AI systems to intervene on the plants regulating systems and/or substitutions. Know how to manage the end of life of the elements of the plant.

3.4. Geothermal pumps installation

Project phase	Short description	Detailed description of competencies	Source	Requirement for the legislation	Digital requirements
Preparation	Understanding geothermal energy in relation to energy performance	Has general knowledge on geothermal energy systems, mostly combined with heat pumps. Has knowledge on the characteristics of different types of systems (e.g. open vs. closed, depth, horizontal vs. vertical).	BIM-EPA	Knowledge of any European standards for heat pumps, and of relevant national and Community law. basic understanding of the physical and operation principles of a heat pump, including characteristics of the heat pump circle: context between low temperatures of the heat sink, high temperatures of the heat source, and the efficiency of the system, determination of the coefficient of performance (COP) and seasonal performance factor (SPF), understanding of the components and their function within a heat pump circle, including the compressor, expansion valve, evaporator, condenser, fixtures and fittings, lubricating oil, refrigerant, superheating and sub-cooling and cooling possibilities with heat pumps	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences
Preparation	Soil investigation on characteristics and suitability	Has knowledge of the soil (composition, humidity, course or fine grained), how to take a sample to determine if geothermal energy can be used. Mostly combined with the expertise of specialised suppliers / advisors.	BIM-EPA	Geothermal resources and ground source temperatures of different regions, soil and rock identification for thermal conductivity, regulations on using geothermal resources	Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc.

Preparation	Perform a feasibility study on use of geothermal energy	Can perform a feasibility study on geothermal energy systems based on costs, restrictions, available components etc. and discuss the outcomes. Can investigate the needed type of system in combination with the available heat pump type. Can determine investment costs based on type of geothermal system and ground conditions.	BIM-EPA	Feasibility of using heat pumps in buildings and determining the most suitable heat pump system, and knowledge about their technical requirements, safety, air filtering, connection with the heat source and system layout	Use BIM 4D and 5D software to evaluate the costs and the time for the intervention. Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements Know how to use openBIM software tools to design the plant.
Design	Engineer geothermal energy systems	Detailed engineering of the geothermal energy system. Can determine construction site boundaries e.g. needed space, area, depth. Make detailed descriptions and drawings of the design.	BIM-EPA	Ability to choose and size the components in typical installation situations, including determining the typical values of the heat load of different buildings and for hot water production based on energy consumption, determining the capacity of the heat pump on the heat load for hot water production, on the storage mass of the building and on interruptible current supply; determine buffer tank component and its volume and integration of a second heating system	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences.
Construction	Specification of a geothermal energy system for contracting purpose	Is able to select products that fit specifications and demands on given quality aspects. Is able to make financial calculations related to contracting phase.	BIM-EPA	Ability to choose and size the components in typical installation situations, including determining the typical values of the heat load of different buildings and for hot water production based on energy consumption, determining the capacity of the heat pump on the heat load for hot water production, on the storage mass of the building and on interruptible current supply; determine buffer tank component and its volume and integration of a second heating system	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant.

Construction	Quality assurance of geothermal energy systems	Can manage, instruct and audit contractors during the realisation of the geothermal energy system, based on information given by the designer and the tender documents. Can audit on construction site, on critical points.	BIM-EPA	Overview of the market situation for heat pumps	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant
Construction	Commissioning of geothermal energy systems	Can commission the geothermal energy installation on functionality in all seasons, under full and partial load. Is aware of critical points and makes sure the designed energy performance is realised.	BIM-EPA	Feasibility of using heat pumps in buildings and determining the most suitable heat pump system, and knowledge about their technical requirements, safety, air filtering, connection with the heat source and system layout	Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Know how to use AI systems to train the facility manager and on field operators.
In use	Design of a maintenance and operation plan	Can design a maintenance and operation plan that guarantees trouble free performance, and instruct the facility manager on the designed performance and monitoring parameters	BIM-EPA	Feasibility of using heat pumps in buildings and determining the most suitable heat pump system, and knowledge about their technical requirements, safety, air filtering, connection with the heat source and system layout	Know how to read the BIM model and update it after each maintenance intervention.
In use	Ensure optimal operation of geothermal energy systems during life cycle	Monitoring and control of the system in order to guarantee the designed performance during life cycle. Takes action on anomalies and adjusts system settings to ensure optimal operation.	BIM-EPA	Feasibility of using heat pumps in buildings and determining the most suitable heat pump system, and knowledge about their technical requirements, safety, air filtering, connection with the heat source and system layout	Know how to read the BIM model and update it after each maintenance intervention.

3.5. Biomass stove and boiler installation

Project phase	Short description	Detailed description of competencies	Source	Requirement for the legislation	Digital requirements
General	Understand biomass systems in relation to energy performance	Has general knowledge on biomass energy production, an holistic view on contribution of biomass to energy performance. Knows the difference between small products (consumer products) and large custom made installations.	BIM-EPA	Ecological aspects, biomass fuels, logistics, fire protection, good knowledge of any European standards for technology and biomass fuels, such as pellets, and biomass related national and Community law	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc.
Pre design	Perform a feasibility study on (large) biomass systems	Is able to perform a feasibility study on energy performance, including financial aspects and discuss the outcomes for large biomass installations.	BIM-EPA	Cost and profitability comparison	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences

Design	Engineer small biomass systems	Detailed engineering of the biomass energy system. Can determine construction boundaries e.g. needed space, weight. Make detailed descriptions and drawings of the design	BIM-EPA	Related subsidies, combustion techniques, firing systems, optimal hydraulic solutions	Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Design	Engineer large biomass installations	Detailed engineering of the biomass energy system. Can determine construction boundaries e.g. needed space, weight. Calculate capacity, flow, temperatures etc. Make detailed descriptions and drawings of the design	BIM-EPA	Design and installation of biomass boilers and stoves	Know how to use openBIM software tools to design the plant. Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant.
Construction	Specify a biomass energy system for contracting purpose	Is able to select products that fit specifications and demands on given quality aspects. Is able to make financial calculations related to contracting phase	BIM-EPA	Overview of the market situation of biomass	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant
Construction	Quality assurance of large biomass installations	Can manage, instruct and audit contractors on site during realisation of large biomass installations, based on information given in tender contracts, the designer and supplier.	BIM-EPA	Design and installation of biomass boilers and stoves	Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc.

Construction	Commission large biomass energy system	Can commission the biomass energy installation on functionality in all seasons, under full and partial load. Can determine if the system operates as planned and makes sure the calculated energy saving is realised.	BIM-EPA	Maintenance of biomass boilers and stoves	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant. Know how to use AI systems to train the facility manager and on field operators.
In use	Design a maintenance and operation plan for large biomass installations	Design a maintenance and operations plan, critical parameters. Give instructions to the user or facility manager.	BIM-EPA	Maintenance of biomass boilers and stoves	Know how to read the BIM model and update it after each maintenance intervention.
In use	Ensure optimal operation during life cycle	Monitor and control the biomass installation on critical parameters, take action on anomalies and ensure optimal operation.	BIM-EPA	Maintenance of biomass boilers and stoves	Know how to manage the monitoring system through the BIM model and intervene when needed.

3.6. The implementation in the different countries

RES Directive		
	Qualification system in place	Note on the use of BUS projects
Denmark		
Ireland	No specific requirements needed for demonstration.	Courses / CPDs on Build Up Skills Advisors app in renewables
Italy	Yes, partially. There is the obligation of recurring training every 3 years for a total of 16 hours with are not sufficient to keep aligned with the new technologies' development	The NQF was updated thanks to the BUS roadmap and the BRICKS project, but the use of training material was not effective.
North Macedonia	Yes, for RES installers	The NQF was updated thanks to the BUS roadmap
Netherland	Yes, for RES installers (heatpump, solar, biomass)	The NQF was extended with choice parts thanks to the Build UP Skills roadmap
Portugal		not found
UK	All heating systems, and performance are part of building control requirements in terms of information supplied. Mechanical Electrical Engineers, or related professionals designing those systems will have to have specific training on those systems to perform the required feasibility studies and provide the design specifications. Also certificates of installation are required. There are continuous developments training available by a number of providers, for example: ● C&G Installation, Service and Maintenance of Environmental Technology Systems (2399) ● GTEC Renewable Training Courses ● BPEC Certification Ltd's Energy Efficiency (accepted by Competent Person's Schemes (CPS) and Microgeneration Certification Schemes (MCS) registration bodies)	not found

- Award in the Installation and Maintenance of Heat Pump Systems (Non-refrigerant Circuits Level 3)

renewable heating systems installers need to be certified by the Microgeneration Certification Scheme (MCS), quality assurance scheme
MCS certification y include:

- Solar PV
- Solar Thermal
- Air Source Heat Pumps
- Ground Source Heat Pumps
- Biomass
- Wind Turbines
- Micro Hydro
- Micro CHP

A company that has installers must belong to a Trading Standards Institute (TSI) approved Consumer Code, so be part of the Renewable Energy Consumer Code (RECC).
an installer, to be a MCS certified installer, you will need to be able to operate a Quality Management System (QMS)

4. The Directives on energy efficiency and on the energy performance of buildings

The European directives do not contain a technical annex describing the competences needed by the workforce to make buildings more energy efficient.
The directives do not specify neither the technologies that can be used to improve energy performance, nor the competences needed to design and install the plants correctly. Therefore, we have used the competences identified and described in another European project through the **CWA 17939.** In the following table, whenever possible, we have joined the effort made within the European projects participating in the BIM EPA network.

4.6. Smart grid

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	LO code	Digital requirements
General	Understand smart grids in relation to energy performance	Has general knowledge and a holistic view on smart grids and buildings' energy profiles, understanding of its contribution to energy performance	BIM-EPA	Participating in discussions for the feasibility study of smart grid systems within a design team.	EN2.1.1	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team as basis for the discussion
General	Information management of smart grids in NZEB design	Can provide the (smart) grid manager with basic information on buildings' energy profiles	BIM-EPA	Performing energy simulations in order to define building energy profiles (e.g. heat load duration curves) based on input from team members.	EN2.1.2	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements

General	Holistic approach of smart grids in NZEB design	Can think in a holistic way concerning energy demand, energy supply, storage and is able to make trade-offs	BIM-EPA			Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team
Preparation	Determine smart grid concepts	Can perform a feasibility study to determine the basic concept within the project, based on energy saving contribution, costs, restrictions, etc.	BIM-EPA	Performing a feasibility study to determine the concept design, based on energy saving contribution, costs, restrictions.	EN2.1.3	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation.
Preparation	Perform energy simulations	Can perform energy simulations in order to define building energy profiles (such as heat load duration curves)	BIM-EPA	Performing energy simulations in order to define building energy profiles (e.g. heat load duration curves) based on input from team members.	EN2.1.2	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements
Preparation	Define energy profiles	Can define the energy profile of the building, i.e. the energy demand profiles, energy supply profiles, storage (in relation with heat pumps), based on input from team members.	BIM-EPA	Defining the energy profile of the building (e.g. energy demand, energy supply and storage profiles) based on input from team members.	EN2.1.3	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements
Design	Engineer smart grids	Can design and calculate the smart grid system, based on heat load duration curves, energy simulations etc.	BIM-EPA	Designing and calculating the smart grid system, based on heat load duration curves and energy simulations. Engineering the automation on distribution grid. Using management and coordination skills to enable grid implementation projects in a complex team.	EN2.1.4	Know how to use openBIM software tools to design the plant. Use CDE to share the architectural, structural, and plants designs.

Design	Find the best solutions			Developing and experimenting innovative solutions for smart grid systems based on emerging components and technologies, interacting with R&D department of companies operating in power electrical engineering. Considering user behaviour (customer databases)	EN2.1.5	Use CDE to share the architectural, structural, and plant designs. Be able to realise a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis. Identify the responsibility matrix: who provides which information to whom and when
Constructi on	Specify smart grids in tender contracts	Can specify and describe the smart grid system in a tender contract, in a way that ensures the contribution to energy saving is realised.	BIM-EPA	Selecting products and technical solutions that fit specifications and demands on given quality aspects and economics related to smart grid systems, ensuring the contribution to energy saving. Writing technical documentation for contracting purpose.	EN2.1.6	Know how to use BIM 4D and 5D software to keep under control time and cost of the works.
Constructi on	Quality assurance of smart grids according contract	Can manage, instruct and audit contractors on site during the realisation of a smart grid system, based on information given in the tender documents and given by the designer.	BIM-EPA	Managing, instructing and auditing contractors on site during the realisation of a smart grid system, based on information given in tender documents and by the design team.	EN2.1.7	Know how to use BIM 4D and 5D software to keep under control time and cost of the works.
Constructi on	Commission smart grids to ensure operation as planned	Can commission a smart grid system on it's functionality and quality, and determine wether the system operates as planned. Make sure the foreseen contribution to energy saving is realised.	BIM-EPA	Commissioning the smart grid system after realisation, in order to check if the system fulfils all demands and functionality. Testing the smart grid system under different conditions. Supporting resolution of disputes, subject to terms of the contract documents.	EN2.1.8	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant.

In use	Ensure optimal operation of smart grids during life cycle	Monitor and control of the smart grid system on critical parameters, in order to guarantee the designed performance during life cycle. Takes action on abnormalities and adjust settings to ensure optimal operation.	BIM-EPA	Designing the operative manual and the maintenance plan of the installed smart grid system. Instructing (the energy manager) on monitoring energy parameters, to ensure the system achieves all designed functionalities during its life cycle.	EN2.1.9	Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed.

4.7. Domotic systems

Project phase	**Short description**	**Detailed description of competencies**	**Source**	**Skill according to CWA 17939**	**LO code**	**Digital requirements**
General	Understand contribution of domotic systems to energy performance	General knowledge on domotic systems, understanding it's contribution to energy saving possibilities	BIM-EPA	Participating in discussions for the feasibility study of domotic systems within a design team.	EN2.2.1	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team
Preparation	Determine energy saving potential regarding human behaviour	Calculate and predict the amount of energy that can be saved by automatic systems and knowledge on the influence of human behaviour on energy demand / use.	BIM-EPA	Performing simplified calculations in order to assess energy saving potential by means of domotic systems, based on input from team members (e.g. occupant behaviour profiles).	EN2.2.2	Know how to connect the BIM model of the plant with an “on field” monitoring system to ensure the best performance of the plant.

Preparation	Determine installations to include in domotic concept	Is able to make a weighting and balancing between which components and systems should be included in domotics and which are less useful to include, in relation to energy saving.	BIM-EPA	Proposing the design concept of the domotic system that fulfils specific needs within the project, based on energy saving contribution.	EN2.2.3	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements Know how to organise the handover and deliver the information to the asset manager. Know how to use AI systems to train the facility manager and on field operators. Know how to manage the monitoring system through the BIM model and intervene when needed.
Preparation	Assess available integrated domotic systems	Is able to choose a concept that fulfils specific needs within the project. Domotic systems are mostly provided by producers of fully integrated systems, including switches, modules etc. Is able to understand designs and specifications provided by producers of integrated systems	BIM-EPA	Understanding and assessing technical specifications provided by producers of integrated systems in order to select the most suitable components and system.	EN2.2.3	Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Design	Engineer a domotic system in NZEB residential buildings	Engineering of a complete domotic system. From design to contract documents and drawings	BIM-EPA	Engineering solutions for domotic systems, verifying which components and systems are more useful to include in relation to energy savings, and considering cost/benefit analysis. Performing simulations to assess energy	EN2.2.4	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements

				reduction by means of a domotic system, considering occupant behaviour profiles.		Use CDE to share the architectural, structural, and plant designs. Use the shared federated model to optimise the design choices and agree with structural and architectural engineer in relation to the placement of the plant.
				Developing and experimenting innovative solutions for domotic systems based on emerging technologies (e.g. IoT based home automation).	EN2.2.5	Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Constructio n	Specify domotic systems in tender contracts	Detailed description of the demands and functionality of the domotic system, to enable the contractor to choose a product that fulfills the demands.	BIM-EPA	Selecting products and technical solutions that fit specifications and demands on given quality aspects and economics related to domotic systems, ensuring the contribution to energy saving. Writing technical documentation for contracting purposes .	EN2.2.6	Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Constructio n	Assure quality of realised systems according contract	Can manage, instruct and audit contractors on site during the realisation of a domotic system, based on information given in the tender documents and given by the designer.	BIM-EPA	Managing, instructing and auditing contractors on site during the realisation of a domotic system, based on information given in tender documents and given by the designer.	EN2.2.7	Know how to organize the handover and deliver the information to the asset manager. Know how to organize the ordinary and predictive maintenance based on the

						information received during the handover Know how to collect information for extraordinary maintenance Know how to read the BIM model and update it after each maintenance intervention.
Constructio n	Commission domotic systems to ensure planned energy saving	Is able to commission the domotic system after realisation, in order to check if the system fulfils all demands and full functionality. This must be done under different conditions (e.g. day/night, residents are present / absent, etc)	BIM-EPA	Commissioning the domotic system after realisation, in order to check if the system fulfils all demands and functionality. Testing the domotic system under different conditions (e.g. in day/night time, in presence/absence of occupants).	EN2.2.8	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant. Know how to manage the monitoring system through the BIM model and intervene when needed.
In use	User instruction to ensure optimal operation of domotic systems	Can write a clear userguide and/or instruct users, based on the type of residents (elderly, young, foreign etc), to see that the system is used as designed in order to achieve the energy saving goals.	BIM-EPA	Designing the operative manual and the maintenance plan of the installed system, for the facility manager and/or for users. Instructing (the facility manager) on monitoring energy and microclimate parameters, to ensure the system achieves designed energy	EN2.2.9	Know how to organize the handover and deliver the information to the asset manager

4.8. Building Management systems BMS (utility buildings)

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	LO code	Digital requirements
General	Understand BMS systems in relation to energy performance	General knowledge on the concept of building management systems and it's contribution to energy saving	BIM-EPA	Participating in discussions for the feasibility study of BMS within a design team.	EN2.3.1	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team
Preparation	Determine installations to include in BMS	Knowledge of installations that can be automised (heating, cooling, sun blinds, lighting, security etc). Is aware of the difference between automatisation strategies for one room or the whole building.	BIM-EPA	Selecting products and technical solutions that fit specifications and demands on given quality aspects and economics related to BMS, ensuring the contribution to energy saving. Writing technical documentation for contracting purposes .	EN2.3.6	Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation.

Preparation	Determine IAQ parameters to be controlled in BMS	Knowledge of essential indoor environmental quality parameters and the impact of the BMS on it's performance	BIM-EPA	Proposing the design concept of the BMS that fulfils specific needs within the project, based on energy savings and IEQ for building users. Understanding and assessing technical specifications provided by producers of BMS in order to select the most suitable components and systems.	EN2.3.3	Know how to use openBIM software tools to design the plant. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Preparation	Determine energy saving potential regarding human behaviour	Knowledge of the amount of energy that can be saved by automatic systems and knowledge on the influence of human behaviour on energy demand / use.	BIM-EPA	Performing simplified calculations in order to assess energy saving potential by means of BMS, based on input from team members (e.g. occupant behaviour profiles).	EN2.3.2	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements
Preparation	Perform a feasibility study	Can perform a feasibility study based on technical aspects as well as return of investment. BMS systems are expensive and will pay back in use phase of the building. During pre-design phase it must become clear how costs of investment can return, who is responsible etc.	BIM-EPA	Participating in discussions for the feasibility study of BMS within a design team.	EN2.3.1	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation

						to the placement of the plant.
Design	Engineer the BMS system in interdisciplinary team	Can design and engineer the building management system in an interdisciplinary team	BIM-EPA	Engineering solutions for BMS in an interdisciplinary team, verifying which components and systems are more useful in relation to energy savings and IEQ, considering cost/benefit analysis (investment return). Performing detailed calculations to assess energy reduction by means of a BMS, considering occupant behaviour profiles and all control and management functions of the selected BMS.	EN2.3.4	Use CDE to share the architectural, structural, and plants designs. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis. Use BIM 4D and 5D software to evaluate the costs and the time for the intervention. Know how to use simulation software to evaluate the right thermal and electric load during the year
Design	Describe functionality and automatisation strategy	Describing the automatisation strategies, what is the demanded functionality. The person who designs the BMS must get input from other design partners on what is needed. (heating/cooling: mechanical engineer. Lighting, security etc: electrical engineer. Sun blinds etc: architect).	BIM-EPA	Developing and experimenting innovative solutions for BMS based on emerging technologies (e.g. combining BEMS and IoT), interacting with R&D department of BMS companies. Integrating passive cooling/heating systems with BMS in smart passive buildings. Performing simulations to assess energy	EN2.3.5	Know how to design a monitoring system to keep under control the energy performance of the building Use openBIM software for a preliminary energy analysis

				reduction, optimising the BMS design in relation to indoor comfort for users.		Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant.
Construction	Specify the BMS for contracting	Specification of building management system for use in contracting. Make detailed descriptions of the BMS strategies, including drawings, so the contractor and supplier can program the hardware / software.	BIM-EPA			Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant Know how to organize the handover and deliver the information to the asset manager
Construction	Assure quality of realised systems according contract	Management, instruction and auditing of contractors during the realisation of the BMS system	BIM-EPA	Managing, instructing and auditing contractors on site during the realisation of a BMS, based on information given in tender documents and given by the design team.	EN2.3.7	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant.
Construction	Commission BMS system to ensure operation as planned	Is able to commission the BMS during, and after realisation, in order to check if the system fulfils all demands and full functionality. This must be done under different conditions (e.g. day/night,	BIM-EPA	Commissioning the BMS after realisation, in order to check if the system fulfils all demands and functionality. Testing the BMS under different conditions (e.g. in day/night time, different seasons, in presence/absence of occupants).	EN2.3.8	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant

		residents are present / absent , winter /summer, etc)				
In use	Ensure optimal operation of the BMS during life cycle	Can design a maintenance plan and instruct the facility manager, to guarantee that the system achieves the energy saving goals. Take action on abnormalities and adjust settings to ensure optimal operation.	BIM-EPA	Designing the operative manual and the maintenance plan of the installed system, for the facility manager and/or for users. Instructing (the facility manager) on monitoring energy and microclimate parameters, to ensure the BMS achieves designed energy savings and comfort goals during its life cycle.	EN2.3.9	Know how to organize the handover and deliver the information to the asset manager

4.9. Heating and cooling GENERAL

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	LO code	Digital requirements
General	Understand influence of heating and cooling generation on energy performance	Has general knowledge on the application and specifics of several types of heating and cooling generation systems. Is able to take part in discussions in the design team. Is aware of the importance of the desicions made in the pre design phase for the total energy performance.	BIM-EPA	Participating in discussions for the feasibility study of heating and cooling systems within a design team	EN3.1.1	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team
General	Understand specifics and basic parameters	Has knowledge on specifics of heating and cooling generation types, and why or when to choose a specific type. E.g. energy sources, energy balance (smart grids)	BIM-EPA	Performing simplified verifications to assess cooling/heating performances of alternative systems, based on input from team members, considering their compliance with energy and indoor comfort requirements	EN3.1.2	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements

Preparation	Assess systems related to building function and architecture	Is able to select heating and cooling systems, specifically in relation with the buildings' architectural design and building function(s). Is able to discuss the relation between architectural design (aesthetics) and selection of heating and cooling systems in a multidisciplinary team	BIM-EPA	Selecting and proposing alternative solutions for heating and cooling systems in residential buildings, specifically in relation to building architectural design and functions, and considering available energy sources (e.g. gas, electricity, district, soil). Pre-sizing the heating/cooling system and assessing the resulting thermal conditions by means of commercial software for building thermal analysis	EN3.1.3	Use simulation tools to identify the best layout of the plant. Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements Know how to use openBIM software tools to design the plant.
Preparation	Determine systems that fit NZEB demands	Can determine the appropriate system in relation to available energy sources (soil, gas, electricity, district etc) and that fit the NZEB demands.	BIM-EPA		EN3.1.3	Know how to use openBIM software tools to design the plant. Use clash detection to solve interferences among the different designs
Preparation	Perform a feasibility study on financial and technical aspects	Is able to perform a feasibility study including financial and technical aspects and discuss the outcomes	BIM-EPA	Engineering solutions for heating/cooling systems for non-residential buildings and complex installations, performing cost/benefit analysis and fulfilling standard requirements. Performing dynamic energy simulations of the cooling/heating system by means of advanced simulation tools, assessing the energy performance of the system and its impact on indoor thermal comfort.	EN3.1.4	Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.

				Developing and experimenting innovative solutions for heating/cooling systems based on emerging components and technologies, interacting with R&D department of HVAC companies. Pursuing the integration of active heating/cooling systems with passive systems and building automation systems. Considering occupant behaviour and the interaction with control systems for cooling/heating. Performing dynamic energy simulations of the building envelope by means of advanced simulation tools. Optimizing heating/cooling systems with respect to thermal comfort, IAQ and acoustic comfort for users.	EN3.1.5	Use simulation tools to identify the best layout of the plant. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
				Selecting components and technical solutions that fit specifications and demands on given quality aspects and economics related to heating and cooling systems, ensuring the contribution to energy saving and IEQ for users. Writing technical documentation for contracting purpose.	EN3.1.6	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant. Define the execution plan within the team to ensure a "lean construction".
Construction				Managing, instructing and auditing contractors on site during the realisation of the heating/cooling system, based on information given in tender documents and given by the designer. Giving feedback to the design team on design and operation suitability of the installed heating/cooling system.	EN3.1.7	Identify the responsibility matrix: who provides which information to whom and when. Know how to use AI systems to train the facility manager and on field operators.

						Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised
Construction				Installing simple heating/cooling systems in a workmanlike manner. Installing complex solutions under supervision of expert team members.	EN3.1.8	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant. Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised
Construction				Installing advanced and complex solutions for heating/cooling systems (e.g. non residential buildings, integration with passive systems in NZEB buildings). Ability to interact with the design team and producers/suppliers of HVAC systems in order to solve problems on construction site.	EN3.1.9	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant. Know how to provide information to the designer to update the model in the case of modification between

						what has been designed and what has been realised
In use				Commissioning the heating/cooling system after realisation, in order to check if the system fulfils all demands and functionality. Testing, adjusting, and balancing the system under different operating conditions. Measuring indoor thermal comfort conditions for building users.	EN3.1.10	Know how to connect the BIM model of the plant with an “on field” monitoring system to ensure the best performance of the plant.
In use				Designing the operative manual and the maintenance plan of the installed system, for the facility manager and/or for users. Instructing (the facility manager) on monitoring energy and microclimate parameters, to ensure the system achieves designed energy savings and comfort goals during its life cycle.	EN3.1.11	Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed.

4.10. Biogas energy production

Project phase	**Short description**	**Detailed description of competencies**	**Source**	**Digital requirements**

General	Understand biogas in relation to other forms of energy production and contribution to energy performance.	Has general knowledge on biogas energy production, which waste materials are used to generate biogas in biogas installations, knows the specifics that characterise biogas systems.	BIM-EPA	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc.
Preparation	Perform a feasibility study on use of biogas energy	Can perform a feasibility study to determine the usefulness of generating biogas from waste materials (e.g. from own activities or form third parties). Is able to determine total cost of ownership. Can consider pros and cons of using biogas or other forms of heat / energy generation.	BIM-EPA	Use openBIM software for a preliminary energy analysis. Use simulation tools to identify the best layout of the plant. Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Design	Integrate biogas energy in the installation concept	Can design and calculate installations for heating and potable hot water (PWH) making use of biogas. The biogas is produced off-site (biogas production is not part of the NZEB project).	BIM-EPA	Use BIM 4D and 5D software to evaluate the costs and the time for the intervention. Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements Know how to use openBIM software tools to design the plant.
Construction	Specify biogas systems in tender contracts	Can specify a biogas energy system for contracting purposes . The realisation of the biomass plant is not part of the project. Is able to select components that are fit for use with biogas.	BIM-EPA	Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Construction	Quality assurance of installations using biogas	Can manage, instruct and audit contractors on site during realisation of the installation for heating and PHW with use of biogas.	BIM-EPA	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant.

				Know how to use AI systems to train the facility manager and on field operators.
Construction	Commissioning of installations using biogas	Can commission installations for heating and PHW that use biogas on quality and functionality and make sure the foreseen contribution to energy saving is realised.	BIM-EPA	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements
In use	Ensure optimal operation of biogas installations	Monitor and control the installations for heating and PHW that use biogas on critical parameters, in order to guarantee the designed performance during life cycle. Can design a maintenance plan.	BIM-EPA	Know how to manage the monitoring system through the BIM model and intervene when needed. Know how to read the BIM model and update it after each maintenance intervention.

4.11. District heating and cooling

Project phase	Short description	Detailed description of competencies	Source	Digital requirements
Preparation	Understand district heating/cooling in relation to other forms of energy production and contribution to energy performance.	Has general knowledge on district heating and cooling systems, knows the specifics that characterize these systems. Understands the contribution to energy saving potential and the boundary conditions.	BIM-EPA	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use clash detection to solve interferences among the different designs
Preparation	Perform a feasibility study on use of district heating and cooling.	Can investigate the need for district heating and cooling, is aware of consequences later on in the project. Can determine heating and cooling demand of the building and demand of potable water.	BIM-EPA	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Use openBIM software for a preliminary energy analysis
Design	Engineer district heating and cooling energy systems	Can engineer a district heating and cooling system, including calculations of heat loss and cooling load, determining of capacity, flow, temperatures, hydraulic concepts etc.	BIM-EPA	Know how to use simulation software to evaluate the right thermal and electric load during the year. Use openBIM software for a preliminary energy analysis
Construction	Specify district heating and cooling systems in tender contracts	Can specify a district heating and cooling energy system for contracting purposes , including description of hydraulic concept.	BIM-EPA	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements.
Construction	Quality assurance of district heating and cooling inside the building	Can manage, instruct and audit contractors on site during realisation of the installation of district heating and cooling systems inside the building and integration with the building installations.	BIM-EPA	Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Use clash detection to solve interferences among the different designs

Construction	Commissioning of district heating and cooling installations, inside the building	Can commission district heating and cooling systems inside the building, on quality and functionality and make sure the foreseen contribution to energy saving is realised. Is able to determine critical parameters for monitoring and control.	BIM-EPA	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant.
In use	Ensure optimal operation of district heating and cooling installations	Monitor and control the district heating and cooling installations inside the building on critical parameters, in order to guarantee the designed performance during life cycle. Can design a maintenance plan.	BIM-EPA	Know how to read the BIM model and update it after each maintenance intervention. Know how to read the information related to the thermal and electric load during the year and intervene if they compromise the comfort of the inhabitants. Know how to manage the monitoring system through the BIM model and intervene when needed.

4.12. Solar absorption cooling

Project phase	**Short description**	**Detailed description of competencies**	**Source**	**Digital requirements**
General	Understand solar absorption cooling systems	Understands the basic working and application of an absorption cooling system. Knows how absorption cooling is regenerated by heat from solar tube collectors. Can explain and discuss the application within the project team.	BIM-EPA	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc.
Preparation	Perform a feasibility study on solar absorption cooling	Can perform a feasibility study on the application of solar cooling, can estimate the cooling demand of the building. Is aware of financial aspects and life cycle analysis.	BIM-EPA	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Use simulation tools to identify the best layout of the plant.

				Use BIM 4D and 5D software to evaluate the costs and the time for the intervention.
Design	Engineer a solar absorption cooling system	Can engineer an absorption cooling generation system with solar regeneration by heat tube collectors. Calculate accurate cooling demand of the building in order to select the right capacity (kW). Can make a detailed design of the installation, principle, automatization strategy, using available products and concepts, select fitted products.	BIM-EPA	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis. Know how to design a monitoring system to keep under control the energy performance of the building
Construction	Specify a solar absorption cooling system in tender contracts	Specify a solar cooling generation system for use in contracting. Is able to select products that fit specifications and demands on given quality aspects. Can make detailed and accurate descriptions and drawings of the design. Is able to make financial calculations related to contracting phase	BIM-EPA	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements Know how to use openBIM software tools to design the plant. Use BIM 4D and 5D software to evaluate the costs and the time for the intervention.
Construction	Quality assurance on realisation of solar cooling systems	Can manage, instruct and audit contractors on site during realisation of a solar cooling system, based on information given by the designer and the tender documents. Is able to instruct the contractor on the specifics of the system. Can audit the realisation of critical points.	BIM-EPA	Use clash detection to solve interferences among the different designs. Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant
Construction	Commission a solar cooling system	Is able to commission the solar cooling system on functionality in all seasons, under full and partial load. Can determine if the installation	BIM-EPA	Know how to connect the BIM model of the plant with an “on field” monitoring system to ensure the best performance of the plant.

		operates as planned, makes sure the foreseen energy performance is realised.		
In use	Ensure optimal operation of solar cooling system	Monitor and control the solar cooling installation on critical parameters, in order to guarantee the designed performance during life cycle. Can design a maintenance plan.	BIM-EPA	Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed.
In use	Communicate the appropriate use and maintenance of the solar cooling system	Can instruct the facility manager on monitoring parameters, to guarantee that the system achieves the designed energy saving goals	BIM-EPA	Know how to use AI systems to train the facility manager and on field operators.

4.13. Mini wind power generation

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	LO code	Digital requirements
General	Understand mini wind power related to nZEB	Understands the basic working and application of mini wind power, is able to explain and discuss within the project team. Is aware of constraints and boundary conditions (regulations, construction, available energy sources)	BIM-EPA	Participating in discussions for the feasibility study of mini wind power generation systems within a design team. Awareness of constraints and boundary conditions for mini wind system installation (e.g. regulations, construction, available energy sources).	EN3.9.1	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team.
Preparation	Perform a feasibility study on mini wind power	Is able to perform a feasibility study on mini wind power including financial aspects. Can estimate needed electrical power demand of the building, can determine the part of mini wind power on total power supply. Understands basic	BIM-EPA	Performing simplified verifications of alternative mini wind power generation systems, based on input from team members, considering available wind in a specific location, height and orientation of wind turbines, technical demands, regulations. Selecting and proposing alternative solutions for mini wind power generation	EN3.9.2 EN3.9.3	Use simulation tools to identify the best layout of the plant. Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Collect and upload into the CDE all the information necessary to make

		principles needed in design and calculation, e.g. orientation, wind, power inverter.		systems in residential buildings, performing a feasibility study on the use of mini wind regarding technical demands, regulations and costs. Estimating the needed electrical power demand and the needed storage in order to define possibilities of mini wind power systems, defining the part of mini wind power on total power supply.		a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc.
Design	Engineer the mini wind power system	Detailed engineering of the mini wind power system, including batteries and power inverters, in coherence with other power supply sources. Engineering of the construction strength for placing mini turbine. Accurate calculation of the needed power (kW)	BIM-EPA	Engineering solutions for mini wind power generation systems at building or cluster scale, including batteries and power inverters, in coherence with other power supply sources and based on detailed calculation of the needed power. Participating in a design team for the connection of wind power generation systems (cluster scale) to urban smart grid systems. Engineering of the construction strenght for placing mini-turbine, considering cost/benefit analysis and permitting/zoning local regulations for mini wind installation. Assessing the impact of mini wind power generation systems at building and landscape scale, and monitoring energy performances overtime.	EN3.9.4	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Know how to use openBIM software tools to design the plant. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis. Use BIM 4D and 5D software to evaluate the costs and the time for the intervention.

Construction	Specify a mini wind power system in tender contracts.	Can specify a mini wind power system for use in contracting. Is able to select products that fit specifications and demands on given quality aspects. Make detailed and accurate descriptions and drawings of the design. Is able to make financial calculations related to contracting phase.	BIM-EPA	Selecting components and technical solutions that fit specifications and demands on given quality aspects and economics related to CHP generation systems, ensuring the contribution to energy saving and IEQ for users. Writing technical documentation for contracting purposes .	EN3.9.6	Know how to use openBIM software tools to design the plant. Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements. Know how to use BIM 4D and 5D software to keep under control time and cost of the works.
				Developing and experimenting innovative solutions for mini wind power generation systems based on emerging components and technologies, interacting with R&D department of specialised companies. Optimising mini wind power systems combining them with multiple renewable energy sources (e.g. PV systems, geothermal) to deliver non-intermittent electric power. Participating in the design process of wind power generation plants at cluster and city scale.	EN3.9.5	Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Use clash detection to solve interferences among the different designs
Construction	Quality assurance of mini wind power	Can manage, instruct and audit contractors on site during realisation of a mini wind power, based on information given by the designer and the tender documents. Is able to instruct the contractor on the specifics of the system.	BIM-EPA	Managing, instructing and auditing contractors on site during the realisation of the mini wind power generation system, based on information given in tender documents and given by the designer. Giving feedback to the design team on design and operation suitability of the installed mini wind system.	EN3.9.7	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant.

		Can audit the realisation of critical points.				
				Installing simple mini wind power generation systems for residential buildings. Installing complex solutions under supervision of expert team members.	EN3.9.8	Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed.
				Installing advanced and complex solutions for mini wind power generation systems (at cluster level). Ability to interact with the design team and producers/suppliers of mini wind systems in order to solve problems on construction site.	EN3.9.9	Know how to use AI systems to train the facility manager and on field operators.
Construction	Commission a mini wind power system	Is able to commission the mini wind turbine on functionality. Can determine if the installation operates as planned, makes sure the foreseen energy performance is realised.	BIM-EPA	Commissioning the mini wind power generation system after realisation, in order to check if the system fulfils all demands and functionality. Testing, adjusting and balancing the system under different operating conditions. Measuring energy performance overtime	EN3.9.10	Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed. Know how to use BIM 4D and 5D software to keep under control time and cost of the works.

In use	Ensure optimal operation of mini wind power during life cycle	Can give instructions to users (or to facility manager). Is able to set up a maintenance plan to ensure optimal operation of the mini wind power system.	BIM-EPA	Designing the operative manual and the maintenance plan of the installed mini wind power generation system, for the facility manager and/or for users. Instructing (the facility manager) on monitoring energy parameters, to ensure the system achieves designed energy savings and functionality during its life cycle.	EN3.9.11	Know how to use AI systems to train the facility manager and on field operators. Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed.

4.14. Combined heat and power (CHP) generation

Project phase	**Short description**	**Detailed description of competencies**	**Source**	**Skill according to CWA 17939**	**Digital requirements**
General	Understand CHP and its contribution to nZEB	Has basic understanding on the principles of combined heat and power generation, can discuss within the project team.	BIM-EPA	Participating in discussions for the feasibility study of CHP generation systems within a design team.	Collect all the legislation requirements and upload them into the CDE
Preparation	Has knowledge on CHP in the project definition phase	Has knowledge on CHP in the project definition phase, regarding regulations, technical demands, energy sources, temperature levels.	BIM-EPA	Performing simplified verifications of alternative micro-CHP systems, based on input from team members, considering available energy sources, technical demands, regulations.	Collect user requirements to identify the different thermal zones in the building and upload in the CDE. Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation,

					latitude, shadows, standard value to be considered, etc.
Preparation	Perform a feasibility study on CHP	Can perform a feasibility study on the use of CHP, regarding technical demands, regulations and costs. Can estimate the needed electrical power and heating demand as well as the heat storage needed in order to determine possibilities of CHP by means of load and load duration curves. Can make an inventory of possible solutions for power supply and heating (energy flows)	BIM-EPA	Selecting and proposing alternative solutions for CHP generation systems in residential/non residential buildings, performing a feasibility study on the use of CHP regarding technical demands, regulations and costs. Estimating the needed electrical power/heating demand and the needed heat storage in order to define possibilities of CHP.	Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use openBIM software for a preliminary energy analysis. Identify the "critical points" to be considered in a monitoring system.
Design	Engineer a CHP system	Engineer the CHP system, Can estimate the heating and cooling demands of the building. Can determine the demands of domestic hot water (average, peak demand). Can make a hydraulic scheme to fit in the CHP unit with a guaranteed return temperature and acceptable on/off switch numbers. Can make a description of the control strategy.	BIM-EPA	Engineering solutions for CHP generation systems for non residential buildings and complex installations (district heating at cluster scale), performing cost/benefit analysis. At building scale, estimating heating/cooling/DHW hourly demand of the building to size the CHP system and defining control strategies by means of BMS technologies. At cluster scale, collaborating in a team to design a CHP generator for district heating. Assessing the impact of CHP generation plants at building and landscape scale, and monitoring CHP performances overtime.	Use simulation tools to identify the best layout of the plant. Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Identify the responsibility matrix: who provides which information to whom and when. Know how to use openBIM software tools to design the plant.

				Developing and experimenting innovative solutions for CHP generator systems based on emerging components and technologies, interacting with R&D department of specialised companies. Partecipating to the design process of district heating at cluster and city scale equipped with CHP generator plants.	Use CDE to share the architectural, structural, and plants designs.
Construction	Specify a CHP-system in tender documents	Specify a CHP-system for use in contracting. Is able to select products that fit specifications and demands on given quality aspects. Can make detailed and accurate descriptions and drawings of the design. Is able to make financial calculations related to contracting phase	BIM-EPA	Selecting components and technical solutions that fit specifications and demands on given quality aspects and economics related to CHP generation systems, ensuring the contribution to energy saving and IEQ for users. Writing technical documentation for contracting purposes .	Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences. Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant.
Construction	Quality assurance of a CHP system	Can manage, instruct and audit contractors on site during realisation of a CHP system, based on information given by the designer and the tender documents. Is able to instruct the contractor on the specifics of the system. Can audit the realisation on critical points.	BIM-EPA	Managing, instructing and auditing contractors on site during the realisation of the CHP system, based on information given in tender documents and given by the designer. Giving feedbacks to the design team on design and operation suitability of the installed CHP system	Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis. Use BIM 4D and 5D software to evaluate the costs and the time for the intervention.
				Installing simple micro-CHP systems for residential buildings. Installing complex solutions under supervision of expert team members	Know how to use simulation software to evaluate the right thermal and electric load during the year
				Installing advanced and complex solutions for CHP systems (e.g. non residential buildings, industrial processes, CHP plants for district heating). Ability to interact with the design team and producers/suppliers	Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences. Use the shared federated model to optimize the design choices and agree with structural

				of CHP systems in order to solve problems on construction site.	and architectural engineers in relation to the placement of the plant. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Construction	Commission a CHP-system	Is able to commission the CPH system on functionality in all seasons, under full and partial load	BIM-EPA	Commissioning the CHP generation system after realisation, in order to check if the system fulfils all demands and functionality. Testing, adjusting and balancing the system under different operating conditions.	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements Define the execution plan within the team to ensure a "lean construction"
In use	Ensure optimal operation of a CHP system	Monitor and control the CHP installation on critical parameters, in order to guarantee the designed performance during life cycle.	BIM-EPA	Measuring energy performance overtime	Know how to design a monitoring system to keep under control the energy performance of the building. Define the maintenance objectives and the handover strategy. Define the execution plan within the team to ensure a "lean construction"
In use	Design a maintanance and operation plan for CHP systems	Design a maintenance and operations plan, determine critical parameters. Give instructions to the user or facility manager.	BIM-EPA	Designing the operative manual and the maintenance plan of the installed CHP generation system, for the facility manager and/or for users. Instructing (the facility manager) on monitoring energy parameters, to ensure the system achieves designed energy savings and functionality during its life cycle.	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant. Know how to use BIM 4D and 5D software to keep under control time and cost of the works.

4.15. Thermal Insulation and envelope systems

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	Digital requirements
General	Understand envelope systems and contribution to energy performance	Has general knowledge on heat transfer within envelope systems, understands the principles and contribution to energy saving.	BIM-EPA		Collect all the legislation requirements and upload them into the CDE. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc.
General	Understand the importance of insulation in relation to nZEB	Has general knowledge on insulation. Understands the basic concept of energy conservation, is able to take part in discussions within a project. Is aware of constraints and boundary conditions (regulations, construction)	BIM-EPA	Participating in discussions for the feasibility study of thermal insulation within a design team.	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Use CDE to share the architectural, structural, and plants designs.
Preparation	Determine the insulation concept within a nZEB project	Understands the concept of energy conservation (reduction of losses) in terms of building shape, zoning of rooms, insulation, airtightness etc. Understands the nature of the thermal bridge. Can discuss and, to some extend evaluate, possible solutions for the thermal bridge problem. Can determine the effect of application of different types of construction elements for	BIM-EPA	Performing simplified energy verification to assess thermal performances of alternative insulation solutions and their compliance with standard requirements Selecting and proposing alternative insulation solutions, focussing on thermal bridge analysis and correction. Assessing the resulting energy performance of the building	Collect user requirements to identify the different thermal zone in the building and upload in the CDE. Use openBIM software for a preliminary energy analysis. Use CDE to share the architectural, structural, and plants designs. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences

		the energy performance of the building.		envelope by means of commercial energy simulation tools.	
Preparation	Investigate envelope systems as means te reach nZEB	Is aware of physical characteristics of envelope systems and their limitations. Can understand the heat transfer principle in the envelope systems. Can explain and address pros and cons of the envelope systems. Can name physical characteristics of such constructions and their limitations.	BIM-EPA		Use simulation tools to identify the best layout of the plant. Use CDE to share the architectural, structural, and plants designs.
Design	Engineer the insulation concept and thermal bridges	Detailed engineering of insulation and solutions for thermal bridges	BIM-EPA	Engineering solutions for thermal insulation and thermal bridges correction, considering cost/benefit analysis and fulfilling standard requirements. Defining solutions for dampness and mold in existing buildings, considering the most suitable correction techniques. Performing dynamic energy simulations of the building envelope by means of advanced building performance simulation tools (BPS), assessing the impact of thermal insulation on indoor thermal comfort.	Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences

				Developing and experimenting innovative solutions for thermal insulation based on emerging technologies. Performing dynamic energy simulations of the building envelope by means of advanced building performance simulation (BPS) tools, optimizing the thermal insulation with respect to indoor comfort and sound insulation.	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements
Design	Design envelope systems	Can perform design of envelop system as a part of complete building energy system.	BIM-EPA		Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences
Construction	Specify the insulation concept in tender documents	Specification of building insulation for contracting purposes . Is able to select products that fit specifications and demands on given quality aspects. Make detailed descriptions and drawings of the design	BIM-EPA	Selecting products and technical solutions that fit specifications and demands on given quality aspects and economics related to thermal insulation. Writing technical documentation for contracting purposes .	Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Be able to realize a BIM library of the plant components and/or use the bSDD to collect

					and use all the properties necessary to make a complete analysis. Know how to use BIM 4D and 5D software to keep under control time and cost of the works.
				Installing traditional solutions for thermal insulation in a workmanlike manner	Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised
				Installing advanced solutions for thermal insulation of NZEB envelopes (e.g. air tightness thermal coat) and for existing buildings affected by dampness and mold problems	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant
Construction	Quality assurance of building insulation	Can manage, instruct and audit contractors on construction site, on critical points. Has knowledge on methodologies to measure quality, e.g. thermography.	BIM-EPA	Managing, instructing and auditing contractors in construction site on the installation of thermal insulation, based on information given in tender documents and by the design team. Giving feedbacks to the design team on critical aspects of the installed thermal insulation	Know how to use AI systems to train the facility manager and on field operators.
Construction	Commission building insulation	Knows how to measure and evaluate the insulation of the building and its effect on building energy performance	BIM-EPA	Performing thermal measurements to detect heat, air and moisture irregularities in building envelopes and to assess indoor conditions. Collecting and analysing data in order to evaluate the thermal insulation quality and its effect on building energy performance. Supporting resolution of disputes, subject to terms of the contract documents.	Know how to connect the BIM model of the plant with an “on field” monitoring system to ensure the best performance of the plant.

Construction	Commission an envelope system	Has knowledge of performance evaluation of the envelope systems.	BIM-EPA		Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant

4.16. Building air tightness

Project phase	**Short description**	**Detailed description of competencies**	**Source**	**Skill according to CWA 17939**	**Digital requirements**
General	Understand the importance of air tightness on energy performance	Has general understanding of the influence of air tightness building on energy performance. Understands the nature of air leakage, is able to take part in discussions within a project.	BIM-EPA	Participating in discussions for the feasibility study of building air tightness within a design team.	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team
Design	Design an air tight building	Can address the air tightness of the building as a part of energy conservation concept. Can guide the design on air tightness towards the desired level of air tightness. Has knowledge on materials, techniques and measures to reach the demanded air tightness.	BIM-EPA	Performing simplified energy verification to assess thermal performances of alternative airtightness solutions for building envelope and their compliance with standard requirements	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation.
Construction	Specify air tightness in tender documents	Specify air tightness for contracting purposes . Is able to select products or suppliers that fit specifications and demands on given quality aspects. Make detailed drawings when needed. Is able to make	BIM-EPA	Selecting and proposing alternative solutions for airtight envelopes. Analysing airtightness testing outcomes (e.g. Blower Door test) in order to drive air leakage points analysis and correction Engineering solutions for airtight	Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant

		financial calculations related to contracting phase		envelopes and air leakage correction, considering cost/benefit analysis and fulfilling standard requirements. Performing dynamic energy simulations of the building envelope by means of advanced BPS tools, assessing the impact of airtightness on indoor air quality and thermal comfort. Selecting products and technical solutions that fit specifications and demands on given quality aspects and economics related to airtight envelope . Writing technical documentation for contracting purpose.	
				Developing and experimenting innovative solutions for airtight envelopes and air leakage correction based on emerging technologies. Performing dynamic energy simulations of the building envelope by means of advanced BPS tools, optimizing the airtightness with respect to indoor air quality, thermal comfort, and sound insulation.	Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements
				Installing airtight opening systems (e.g. doors, windows) in a workmanlike manner.	Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant.

					Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences
				Installing advanced solutions for thermal insulation of NZEB envelopes (e.g. airtight thermal coat).	Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised
Construction	Quality assurance on air tightness	Can manage, instruct and audit contractors on construction site, on critical points. Has knowledge on methodologies to measure quality, e.g. blower door test.	BIM-EPA	Managing, instructing and auditing contractors in construction site on the installation of airtight materials and opening systems for building airtightness, based on information given in tender documents and by the design team. Giving feedback to the design team on critical aspects of the installed thermal airtightness envelope.	Know how to read the BIM model and update it after each maintenance intervention. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences.
Construction	Commission building air tightness	Knows how to measure and evaluate the air tightness of the building and its effect on building energy performance.	BIM-EPA	Performing air leakage measurements to detect heat, air and moisture irregularities in building envelopes and to assess indoor conditions. Collecting and analysing data in order to evaluate the thermal insulation quality and its effect on building energy performance. Supporting resolution of disputes, subject to terms of the contract documents.	Know how to connect the BIM model of the plant with an “on field” monitoring system to ensure the best performance of the plant. Know how to use AI systems to train the facility manager and on field operators.

4.17. Micro-climates

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	Digital requirements
General	Understand micro climates in nZEB projects	General knowledge on mirco climates. Can understand the interplay between micro climate, buildings and their services. Understands climatic design principles.	BIM-EPA		Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team
Preparation	Investigate mirco climates as strategy to reach nZEB	Can investigate the appropriate solution and is aware of the importance of early decisions later in the project. Has knowledge of the main passive design strategies (i.e. daylight, passive cooling, natural cooling, thermal mass, solar heating, etc.)	BIM-EPA		Use simulation tools to identify the best layout of the plant.
Design	Design of micro climates in nZEB	Can discuss and evaluate climatic and local conditions on the site for application of optimal passive strategies (micro and macro climate). Can understand, evaluate and follow climatic design strategies for an optimal energy performance. Can combine several design strategies and evaluate their performance as a whole building energy concept. Can perform optimal design of	BIM-EPA		Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team. Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation.

		buildings according to micro and macro climate.			Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences

4.18. Hot water systems

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	Digital requirements
General	Understand function of hot water systems	General knowledge on hot water distribution systems, is aware of it's function to distribute heating, cooling and potable hot water.	BIM-EPA	Participating in discussions for the feasibility study of DHW systems within a design team. Performing simplified verifications for alternative DHW systems in residential buildings, considering user needs and based on input from team members	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team
Preparation	Investigate solutions for distribution of heating, cooling, potable hot water.	Understands the design principles of water distribution systems for e.g. heating, cooling and domestic hot water and the relation with insulation, energy saving by optimal hydraulic design. Understands the nature of energy loss in these systems caused by heat transfer, pressure loss (resistance of tubes and valves) and electrical power for pumps and valves. Is able to avoid large distribution systems	BIM-EPA	Selecting and proposing alternative solutions for DHW systems in residential buildings, considering potential energy savings by optimal hydraulic design and tube insulation. Pre-sizing the DHW system in relation to building functions and occupant profiles.	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Know how to use openBIM software tools to design the plant.

		when possible, by other solutions.			
Design	Engineer hot water systems	Can engineer a hot water distribution system for e.g. heating, potable hot water. Can perform the design of the system regarding insulation and solutions for heat recovery. Can describe and explain physical properties (e.g. static/dynamic pressure, authority, velocity, heat transfer). Is aware of the influence of insulation on total energy demand. Can calculate the needed insulation thickness	BIM-EPA	Engineering solutions for DHW systems in non-residential buildings, performing detailed calculation of needed capacity and storage under given conditions and cost/benefit analysis for different solutions. Pursuing the integration of DHW systems with renewable energies (e.g. solar thermal energy systems). Performing detailed simulations of thermal energy demand for the DHW system by means of advanced simulation tools, assessing the energy performance of the system and its impact on energy savings.	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation.
				Developing and experimenting innovative solutions for DHW systems based on emerging components and technologies, interacting with R&D department of specialised companies. Pursuing the integration of DHW systems with other active or passive heating systems, and with building automation systems. Performing dynamic energy simulations of the DHW system by means of advanced simulation tools, in order to optimize the system with respect to energy consumption, occupant profiles and occupant needs.	Know how to use simulation software to evaluate the right thermal and electric load during the year Use dynamic software tools to evaluate “what-if” to find the best technical-economic solution meeting the client’s requirements. Know how to use openBIM software tools to design the plant. Use CDE to share the architectural, structural, and plants designs. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences.

Design	Hydraulic balancing of hot water systems	Can make a hydraulic balancing calculation, is able to calculate and select projects and components in the installation e.g. A-label pumps, balancing valves.	BIM-EPA	Selecting components and technical solutions that fit specifications and demands on given quality aspects and economics related to DHW systems, ensuring service for users and the contribution to energy saving. Installing DHW systems in a workmanlike manner for residential buildings. Installing complex solutions under supervision of expert team members.	Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
				Installing advanced and complex solutions for DHW systems (e.g. non-residential buildings as swimming pools, gyms) and managing the integration with domotic systems and BMS. Ability to interact with the design team and producers/suppliers of DHW systems in order to solve problems on construction site.	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant.
Construction	Specify distribution systems in tender documents	Specification of a distribution system for contracting purposes , including drawings, hydraulic schemes, quality aspects and valves and monitoring devices.	BIM-EPA	Writing technical documentation for contracting purposes .	Know how to read the BIM model and update it after each maintenance intervention. Know how to read the information related to the thermal and electric load during the year and intervene if they compromise the comfort of the inhabitants.
Construction	Quality assurance on distribution systems	Can manage, instruct and audit contractors on correct realisation of water distribution systems, hydraulic balancing and setting of parameters e.g. flow and temperatures	BIM-EPA	Managing, instructing and auditing contractors on site during the realisation of the DHW system, based on information given in tender documents and given by the designer. Giving feedback to the design team	Know how to use AI systems to train the facility manager and on field operators.

				on design and operation suitability of the installed DHW system.	
Construction	Commission a hot water distribution system	Is able to commission the distribution system on functionality in all seasons, under full and partial load. Can determine if the installation operates as planned, makes sure the foreseen energy performance is realised.	BIM-EPA	Commissioning the DHW system after realisation, in order to check if the system fulfils all demands and functionality. Testing, adjusting and balancing the system under different operating conditions.	Know how to use AI systems to intervene on the plants regulating systems and/or substitutions
In use	Ensure optimal operation of hot water distribution systems	Can design a maintenance plan and instruct the facility manager, to guarantee that the system achieves the designed energy saving goals, including hydraulic balancing en monitoring parameters.	BIM-EPA	Designing the operative manual and the maintenance plan of the installed DHW system for users. Ensuring the system achieves designed energy savings and operativity during its life cycle.	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant. Know how to use AI systems to train the facility manager and on field operators.

4.19. Window and/or glazing systems

Project phase	**Short description**	**Detailed description of competencies**	**Source**	**Skill according to CWA 17939**	**Digital requirements**
General	Understand window / glazing systems in relation to energy performance	General knowledge on window and/or glazing systems	BIM-EPA	Participating in discussions for the feasibility study of window/glazing systems within a design team.	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team

Design	Engineer window / glazing systems	Can understand and address the heat transfer principle in a glazing system. Can calculate properties of the glazing system. Can describe and explain physical properties of the glazing system (i.e. g-value, u-value, light transmittance.	BIM-EPA	Performing simplified verification to assess daylight factor and thermal performances of alternative glazing solutions for building envelopes , considering their compliance with standard requirements.	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation.
				Selecting and proposing alternative solutions for windows or glazing envelopes, focussing on thermal insulation and seasonal solar heat gain. Assessing the resulting energy and daylighting performance of the building envelope by means of commercial energy simulation tools.	Know how to use simulation software to evaluate the right thermal and electric load during the year. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
				Engineering solutions for glazing envelopes, fixing thermal bridging, considering cost/benefit analysis and fulfilling standard requirements.	Know how to use simulation software to evaluate the right thermal and electric load during the year. Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements. Use simulation tools to identify the best layout of the plant.
				Developing and experimenting innovative solutions for glazing envelopes based on emerging technologies (e.g. smart glazing with passive/active dynamic control), interacting with R&D department of glazing companies. Performing dynamic energy simulations of the	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.

				building envelope by means of advanced simulation tools. Optimizing glazing envelope solutions with respect to visual comfort (sunlight glare control) and acoustic comfort (facade sound insulation), considering optical and acoustic properties of glazing systems.	
Preparation	Design energy efficient solutions for window / glazing systems	Can discuss and design window/glazing system for optimal comfort and energy performance. Can understand the effect of shading device for performance of a glazing system. Can evaluate and design optimal shading system and its control strategy.	BIM-EPA	Selecting products and technical solutions that fit specifications and demands on given quality aspects and economics related to window/glazing systems. Writing technical documentation for contracting purposes .	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements. Know how to design a monitoring system to keep under control the energy performance of the building.
				Installing traditional solutions for glazing (windows, skylights) in a workmanlike manner. Installing complex solutions under supervision of expert team members	Know how to read the BIM model and update it after each maintenance intervention. Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised.
				Installing advanced solutions for glazing (e.g. dynamic glazing technologies, solartubes) and automatic window openers. Ability to interact with the design team and producers/suppliers of glazing systems	Know how to read the BIM model and update it after each maintenance intervention. Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised.

				in order to solve problems on construction site.	Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences.
				Managing, instructing and auditing contractors in construction site on the installation of windows and glazing systems, based on information given in tender documents and by the design team. Giving feedback to the design team on critical aspects of the installed glazing systems.	Know how to read the BIM model and update it after each maintenance intervention. Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences.
				Performing thermal measurements to detect heat and air leakages in windows/glazing systems. Performing photometric/colorimetric measurements to assess optical properties of glazing. Performing building acoustic measurements to assess sound insulation properties of glazing. Collecting and analysing data in order to evaluate building energy performance, daylighting and sound insulation loss. Supporting resolution of disputes, subject to terms of the contract documents.	Know how to design a monitoring system to keep under control the energy performance of the building Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Know how to use AI systems to train the facility manager and on field operators.

4.20. Heating and cooling emission systems

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	Digital requirements
General	Understand heating and cooling emission in relation to comfort and energy performance	General knowledge on heating and cooling emission systems, influence on human comfort and energy demand. Understanding of relation with heating and cooling generation, high and low temperatures.	BIM-EPA		Collect and upload into the CDE all the information necessary to make a preliminary energy analysis, for instance: orientation, latitude, shadows, standard value to be considered, etc. Use openBIM software for a preliminary energy analysis.
Preparation	Investigate energy efficient solutions for heating and cooling emission	Understands the basic design principles of heating and cooling emission systems and can explain, regarding human comfort and energy use. Can investigate and select the appropriate system according to the heating and cooling generation system. Understands the specifics of high temperature cooling and low temperature heating. Is familiar with the specifications and functionality of e.g. climate ceilings, radiators, wall-heating, floor-heating, convectors, induction air units.	BIM-EPA		Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.

Design	Engineer heating and cooling emission systems	Can design and evaluate solutions for different types of rooms and spaces regarding square metres, height, human comfort and occupation (Fanger model, PMV), adaptation and control strategies. Is able to design a system taking into account the relation with the heating and cooling generation system	BIM-EPA		Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements
Construction	Specify heating and cooling emission systems in tender contracts	Specify heating/cooling emission systems for contracting purpose. Can make detailed drawings and descriptions of the demanded systems, in a way the contractor can offer a system or products that fulfil the demands.	BIM-EPA		Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements. Know how to use openBIM software tools to design the plant.
Construction	Quality assurance of heating / cooling emission systems	Can manage, instruct and audit contractors on site during realisation of heating/cooling systems, based on information given by the designer and the tender documents. Is able to instruct the contractor on the specifics of the system. Can audit the realisation on critical points.	BIM-EPA		Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant.
Construction	Commission heating / cooling	Is able to commission the heating / cooling emission system on functionality in all seasons, under full and	BIM-EPA		Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant.

	emission systems	partial load. Can determine if the installation operates as planned, makes sure the foreseen energy performance is realised.			
In use	Ensure optimal operation of heating / cooling emission systems	Can set up a maintenance plan and give instructions to users in order to maintain settings and energy efficiency	BIM-EPA		Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed. Know how to use AI systems to train the facility manager and on field operators.

4.21. Electric heating systems

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	Digital requirements
General	Understand contribution of electrical heating to NZEB	Has general knowledge on electric heating, understands the basic working and properties of electric heating systems, is able to take part in discussions. Is aware of the potential contribution to energy saving by local heating. Is aware of the interactions between electric heating versus power supply capacity.	BIM-EPA	Participating in discussions for the feasibility study of electric heating systems within a design team. Performing simplified verifications to assess heating performances of alternative electric heating systems, based on input from team members and considering their compliance with energy and thermal comfort requirements.	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team.

Preparation	Perform a feasibility study on electric heating	Is able to performe a feasibility study in order to determine wether application of electric heating is appropriate and sustainable under the given conditions (e.g. room occupation, temperature, comfort, available heat/energy source, construction of walls/floors/ceiling). Is familiar with different types of electric heating systems (Infra red, floor and wall heating foil or panels).	BIM-EPA	Performing a feasibility study to assess if electric heating is appropriate and sustainable under different conditions (e.g. room with low occupation frequency, thermal comfort requirements, construction of wall/ceiling/floor, high insulated building envelope, available heat/energy sources). Selecting and proposing alternative solutions for electric heating systems, specifically in relation to building functions, thermal comfort requirements and available renewable energy sources.	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Use BIM 4D and 5D software to evaluate the costs and the time for the intervention.
Design	Engineer an electric heating system.	Detailed engineering of electric heating systems. Is able to calculate the needed capacity for space heating under given conditions. Has specialistic knowledge of radiation heating, PMV, properties and human interaction (e.g. how to design for high spaces). Is able to comply with available electrical power supply.	BIM-EPA	Engineering solutions for electric heating systems, performing detailed calculation of needed capacity for space heating under given conditions thanks to specialistic knowledge on radiant heating (also for design in high spaces) and thermal comfort assessment by PMV index. Performing cost/benefit analysis and assessment of electric contribution by renewable energy sources. Performing dynamic energy simulations of the electric heating system by means of advanced simulation tools, assessing the energy performance of the system and its impact on indoor thermal comfort.	Know how to use simulation software to evaluate the right thermal and electric load during the year.

				Developing and experimenting innovative solutions for electric heating systems based on emerging components and technologies, interacting with the R & D department of specialised companies. Pursuing the integration of electric heating systems with other active or passive heating systems, and with building automation systems. Performing dynamic energy simulations of the electric heating system by means of advanced simulation tools, in order to optimise the system with respect to energy consumption, occupant behaviour (frequency in using a space) and thermal comfort.	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements. Know how to use openBIM software tools to design the plant. Use CDE to share the architectural, structural, and plant designs. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences.
Construction	Specify electric heating systems in tender documents	Is able to define and specify the electric heating system for use in the contracting phase.	BIM-EPA	Selecting components and technical solutions that fit specifications and demands on given quality aspects and economics related to electric heating systems, ensuring the contribution to energy saving and thermal comfort for users. Writing technical documentation for contracting purpose.	Use the shared federated model to optimise the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Know how to read the BIM model and the BIM library and/or bSDD where to find instruction to install the plant.
				Installing simple electric heating systems in a workmanlike manner. Installing complex solutions under supervision of expert team members.	Use clash detection to solve interferences among the different designs. Use the shared federated model to optimise the design choices and agree with structural and architectural engineers in relation to the placement of the plant.

				Installing advanced and complex solutions for electric heating systems (e.g. non-residential buildings, integration with passive systems in NZEB buildings). Ability to interact with the design team and producers/suppliers of electric heating systems in order to solve problems on construction site.	Know how to read the BIM model and update it after each maintenance intervention. Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised. Know how to use the BIM Collaboration Format to underline and solve any issue during the construction
Construction	Quality assurance of electric heating	Can instruct, manage and audit contractors on site during realisation of an electric heating system, to ensure the designed energy saving goals are met.	BIM-EPA	Managing, instructing and auditing contractors on site during the realisation of the electric heating system, based on information given in tender documents and given by the designer. Giving feedback to the design team on design and operation suitability of the installed electric heating system.	Know how to read the BIM model and update it after each maintenance intervention. Know how to provide information to the designer to update the model in the case of modification between what has been designed and what has been realised Know how to use the BIM Collaboration Format to underline and solve any issue during the construction. Know how to use AI systems to train the facility manager and on field operators.
Construction	Commission electric heating systems	Commission an electric heating system on functionality, energy efficiency and human comfort.	BIM-EPA	Commissioning the electric heating system after realisation, in order to check if the system fulfils all demands and functionality. Testing and adjusting the system under different operating conditions. Measuring indoor thermal comfort conditions for building users.	Know how to manage the monitoring system through the BIM model and intervene when needed. Know how to connect the BIM model of the plant with an “on field” monitoring system to ensure the best performance of the plant.

In use	Ensure optimal operation of electric heating systems	Can design a maintenance plan and instruct the facility manager on monitoring parameters, to guarantee that the system achieves the designed energy saving goals	BIM-EPA	Designing the operative manual and the maintenance plan of the installed system, for the facility manager and/or for users. Instructing (the facility manager) on monitoring energy and microclimate parameters, to ensure the electric heating system achieves designed energy savings and comfort goals during its life cycle.	Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed. Know how to organise the ordinary and predictive maintenance based on the information received during the handover

4.22. Artificial lightning systems

Project phase	**Short description**	**Detailed description of competencies**	**Source**	**Skill according to CWA 17939**	**Digital requirements**
General	Understand artificial lighting systems in relation to energy performance in NZEB	Understands and can explain the basic design principles of artificial lighting systems. Has general knowledge on different types of lighting and contribution to energy efficiency.	BIM-EPA	Participating in discussions for the feasibility study of an indoor lighting system within a design team.	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team.

Preparation	Investigate energy efficient solutions for artificial lighting regarding human factors.	Can investigate solutions for artificial lighting systems, taking into account human comfort, energy efficiency, maintenance, costs.	BIM-EPA	Performing simplified calculation to size alternative solutions of the indoor lighting system. Applying fundamentals of visual comfort in simple projects. Selecting and proposing alternative lighting systems, focussing on visual comfort analysis for indoor workplaces. Assessing the resulting performance of the lighting system by means of commercial simulation tools, in order to fulfil standard requirements and to visualize render images of the lighting design concept.	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation.
Design	Engineer an artificial lighting system	Can design an artificial lighting system based on e.g. daylight, timer, occupation of spaces. Is aware of technical specifications and restrictions, such as power quality and energy efficiency (LED, HF fluorescent lighting). Is aware of the influence of used materials in light bulbs/LEDs on the environment (chemical elements, mercury…)	BIM-EPA	Engineering solutions for indoor lighting, defining the most suitable lighting system with respect to building constraints and functions, cost/benefit analysis, standard requirements on visual comfort. Achieving energy use reduction for artificial lighting by means of high efficiency light sources (e.g. Solid State Lighting for retrofitting solutions), light control systems, daylight integration	Know how to use openBIM software tools to design the plant.

Construction	Specify artificial lighting in tender documents.	Specify an artificial lighting system for contracting purposes. Choose products that fit specifications of lighting (lux, lumen) as well as electric restrictions (power quality), taking into account sustainability of products.	BIM-EPA	Optimising the artificial lighting system for indoor workplaces to provide users with appropriate light exposure for maintaining circadian health and aligning the circadian rhythm with the day-night cycle. Experimenting innovative solutions for circadian lighting based on emerging technologies (e.g. tunable white LEDs, control systems to enhance daylight access). Selecting products and technical solutions that fit specifications and demands on given quality aspects and economics related to lighting systems for indoor workplaces. Writing technical documentation for contracting purpose	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements. Know how to use openBIM software tools to design the plant. Know how to use simulation software to evaluate the right thermal and electric load during the year
				Installing the lighting system according to the specified design documentation, taking account of installation procedure and safety regulations	Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences
				Installing alternative lighting products based on the evaluation of product equivalence* according to the following criteria: aesthetic, light output and colour tonality, energy consumption, construction quality. (*)	Use dynamic software tools to evaluate "what-if" to find the best technical-economic solution meeting the client's requirements.

				If a product replacement is allowed through the process by the contract.	
Construction	Commission an artificial lighting system	Can commission artificial lighting systems on quality and functionality and make sure the foreseen contribution to energy saving is realised.	BIM-EPA	Managing, instructing and auditing contractors on critical aspects during the installation of the lighting system. Performing spot measurements of illuminance on visual tasks to confirm design values to specified lighting criteria. Verifying and delivering operation and maintenance instructions.	Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
				Performing photometric measurements to assess visual comfort in indoor workplaces (illuminance levels and uniformity, luminance distribution, glare) and lighting performance verification (flickering, spectral distribution, colour temperature, colour rendering index). Collecting and analysing data in order to evaluate the lighting quality and its effect on visual comfort.	Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant. Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed. Know how to use AI systems to train the facility manager and on field operators.

4.23. Ventilation systems

Project phase	Short description	Detailed description of competencies	Source	Skill according to CWA 17939	Digital requirements
General	Understand ventilation systems in relation to energy performance	Has general knowledge on ventilation systems, understands basic principles, is aware of the importance of IAQ on human performance and wellbeing. Is familiar with concepts of oxygen, exhaust of carbon dioxide, pollution, allergens.	BIM-EPA	Participating in discussions for the feasibility study of ventilation systems within a design team.	Use laser scanner and other advanced tools to obtain a GIS-BIM model of the area and/or the building to be shared on the CDE with the designer team Use CDE to share the architectural, structural, and plants designs. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences
General	Understand basic design principles of ventilation and IAQ systems.	Understands the basic design principles of ventilation systems, such as natural, semi natural and mechanical systems, central or decentral (façade) systems.	BIM-EPA	Selecting and proposing alternative solutions for ventilation in residential buildings, specifically in relation to building architectural design and functions, and considering climatic conditions for natural ventilation. Designing ventilation air flow rates with methods based on perceived air quality or based on limit values of substance concentration (EN standard methods).	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation. Know how to use openBIM software tools to design the plant.
Preparation	Advise on required IAQ	Explain, discuss and advise to project developer and future user which minimum indoor air quality is wished for.	BIM-EPA	Performing simplified verifications of air change rates for alternative ventilation systems, based on input from team members, considering their compliance with IAQ requirements (EN standard method based on predefined air flow rates).	Use energy analysis tools to evaluate the size of the plants depending on the inhabitants needs and seasonal fluctuation.

Preparation	Investigate and select fitted ventilation systems	Can investigate and advise on a ventilation system that fits the energy demands but also guarantees good indoor air quality according the minimum IAQ levels. Is open to alternative ways of ventilation (e.g. stack ventilation, use of chimney effect). Also advises on need or use of opening windows.	BIM-EPA	Developing and experimenting innovative solutions for ventilation systems based on emerging components and technologies, interacting with R&D of specialised companies and performing in situ measurements of IEQ and energy performances. Pursuing the integration of natural ventilation with passive cooling systems and building automation systems. Considering occupant behaviour and the interaction with control systems for ventilation. Performing dynamic energy simulations of the building by means of advanced simulation tools. Optimizing the ventilation system with respect to energy performance and IAQ, thermal comfort and acoustic comfort for users.	Know how to use simulation software to evaluate the right thermal and electric load during the year. Be able to realize a BIM library of the plant components and/or use the bSDD to collect and use all the properties necessary to make a complete analysis.
Preparation	Perform energy calculation of ventilation systems	Can calculate and evaluate the total energy use of the ventilation system regarding electrical power consumption, heat loss of the system and the building, on a yearly basis in order to select a fitted concept.	BIM-EPA		Know how to use simulation software to evaluate the right thermal and electric load during the year. Use CDE to share the architectural, structural, and plants designs. Use clash detection to solve interferences among the different designs. Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant.
Preparation	Advise on natural ventilation	Can advise on the use of natural ventilation at night	BIM-EPA		Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant.

	for (summer) night cooling	to cool down the building during summer time.			
Design	Engineer a ventilation system	Can engineer a ventilation system, regarding future aspects of maintenance. Knows the interplay between an nZEB building, it's use (occupation) and the right ventilation strategy. Can design a system regarding specific needs of the building and its users. Engineer the air ducts, inlets, outlets, fans, filters etc.	BIM-EPA	Selecting components and technical solutions that fit specifications and demands on given quality aspects and economics related to ventilation systems, ensuring the contribution to energy saving and IEQ for users. Writing technical documentation for contracting purposes .	Know how to use openBIM software tools to design the plant. Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Know how to design a monitoring system to keep under control the energy performance of the building.
Construction	Specify a ventilation system in tender contracts	Can specify the design, describe important specifications, make drawings of the ventilation system, in a way that ensures optimal performance on energy and IAQ (indoor air quality).	BIM-EPA	Engineering solutions for ventilation systems in non residential buildings and complex installations, performing cost/benefit analysis and fulfilling standard requirements. Pursuing the integration of natural ventilation with mechanical ventilation and building automation systems. Performing dynamic simulations of ventilation and cooling/heating effects by means of advanced simulation tools, assessing the energy performance of the system and its impact on IAQ and indoor thermal comfort.	Use the shared federated model to optimize the design choices and agree with structural and architectural engineers in relation to the placement of the plant. Know how to use openBIM software tools to design the plant. Know how to use simulation software to evaluate the right thermal and electric load during the year.

Construction	Quality assurance of a ventilation system according tender contract	Can manage, instruct and audit contractors on site during realisation of the ventilation systems, based on information given by the designer and the tender contracts.	BIM-EPA	Managing, instructing and auditing contractors on site during the realisation of the ventilation system, based on information given in tender documents and given by the designer. Giving feedback to the design team on design and operation suitability of the installed ventilation system.	Know how to use AI systems to train the facility manager and on field operators. Know how to connect the BIM model of the plant with an "on field" monitoring system to ensure the best performance of the plant.
				Installing domestic VMC systems in a workmanlike manner. Installing complex solutions under supervision of expert team members.	Know how to read the BIM model and update it after each maintenance intervention. Know how to manage the monitoring system through the BIM model and intervene when needed.
Construction	Commission a ventilation system in relation to energy performance and IAQ	Can commission a ventilation system on functionality, quality and realised energy performance. Can determine whether the system operates as planned and the designed energy performance is realised.	BIM-EPA	Commissioning the ventilation system after realisation, in order to check if the system fulfils all demands and functionality . Testing, adjusting and balancing the system under different operating conditions. Measuring IAQ and thermal comfort conditions for building users.	Know how to use AI systems to train the facility manager and on field operators.
				Installing advanced and complex solutions for ventilation systems (e.g. non residential buildings, integration with passive cooling systems) and managing the integration with domotic systems and BMS. Ability to interact with the design team and producers/suppliers of ventilation systems in order to solve problems on construction site.	Know how to manage the monitoring system through the BIM model and intervene when needed. Use CDE to share the architectural, structural, and plants designs. Use BIM Collaboration Format to raise issues and/or propose solutions in relation to possible interferences

In use	Ensure optimal operation of ventilation systems on energy performance and IAQ	Can monitor and control the ventilation system on critical performance parameters, in order to guarantee performance as designed. This includes monitoring of settings, design of a maintainance plan for cleaning of air ducts, filters etc.	BIM-EPA	Designing the operative manual and the maintenance plan of the installed ventilation system, for the facility manager and/or for users.	Know how to manage the monitoring system through the BIM model and intervene when needed.
In use	Communicate with customers on appropriate use of ventilation	Can instruct building users in order to make sure the system is used as designed for in relation to energy performance and IAQ.	BIM-EPA	Instructing (the facility manager) on monitoring energy and microclimate parameters, to ensure the system achieves designed energy savings and comfort goals during its life cycle.	Know how to use AI systems to train the facility manager and on field operators.

4.24. The implementation in the different countries

Energy Performance Directives		
	Qualification system in place	**Note on the use of BUS projects**
Denmark		
Ireland	Energy performance certificate (EPC) required in response to EPBD energy performance requirements. Quality assessment of EPCs are carried out by EPC assessors. Building Energy Rating (BER) Assessors and Display Energy Certification (DEC) Assessors are required from time to time to update their skills/resources to approve renewal of registrations.	Courses / CPDs on Build Up Skills Advisors app in building energy performance
Italy	There are no specific requirements for the demonstration of the competences of each domain. There is only a generic requirement for electricians, plumbers, etc.	The NQF was updated thanks to the BUS roadmap and the BRICKS project, but the use of training material was not effective.
North Macedonia	There are no specific requirements for the demonstration of the competences for the design phase. There is only a generic	n/a

	requirement for designers (architects and engineers). On the other hand, there is a specifically and detailed competence of Energy Auditors	
Netherland	Energy performance certificate (EPC) required in response to EPBD energy performance requirements. Quality assessment of EPCs are carried out by certified EPC assessors.	n/a as everything needed to train and certify is organised under supervision of the Ministry of Internal Affairs.
Portugal	Energy certificates are legal requirements. And in terms of building regulations for example: Thermal efficiency legislation has been improved in the past few years in terms of requirements. There are specific courses that a person needs to take to be qualified and an auditor. For example, according to *ADENE - Agência para a Energia*: "SCE technicians are independent professionals who work in the Energy Certification of Buildings (recognized by ADENE) and who work as Qualified Experts (PQ) for energy certification or as other SCE Technicians (TRM, TGE and TIS) for installation and maintenance of buildings and systems, as well as management of energy consumption in buildings and periodic inspection of technical systems covered by the SCE" source:	not found
UK	There are no specific requirements for the demonstration of the competences for the design phase. There is only a generic requirement for designers (architects and engineers). Such professionals have mandatory CPDs in relation to energy efficiency and their degrees integrate subjects as energy efficiency, thermal performance, climate change, renewals, in their course learning outcomes and contents. The Energy Assessment is a regulated industry in the UK . It relates to domestic buildings, non-domestic and commercial buildings, and air-conditioning systems, among others.	not found specifics.

. The Air-Conditioning Energy Assessor undertakes mandatory inspections of all air conditioning systems with rated outputs of over 12kw at intervals not exceeding 5 years.

Energy certificates are legal requirements.

There are specific technicians that deal with auditing and issuing certificates, for example: Domestic Energy Assessors (DEAs) can provide you with an Energy Performance Certificate. According to C&G: *“The Domestic Energy Assessor produces an Energy Performance Certificate (EPC) using the most recent version of RdSAP when a building is sold or let, and an accredited Assessor can deal with both the sales and lettings markets. “*

There are specific training for specific assessors such:

- Energy Assessor Training
- Domestic Energy Assessor (DEA)
- Non-Domestic Energy Assessor (NDEA), according to C&G: “ *collects data on dimensions, construction, heating and hot water provision of commercial and non-commercial buildings in order to produce an EPC using the Simplified Building Energy Model (SBEM)”*
- On Construction Domestic Energy Assessor (OCDEA)
- Display Energy Certificate (DEC)
- Air Conditioning Inspection (ACI), according to C&G: *“undertakes mandatory inspections of all air conditioning systems with rated outputs of over 12kw at intervals not exceeding 5 years”*

According to C&G: “*Domestic and Non-Domestic Energy Assessment forms part of the Green Deal Advisor qualification. Individuals that currently hold the DEA or NDEA qualifications can 'upskill' to Green Deal Advice*.”

There are training institutions in the UK that can train these technicians, such as C&G or private training center.

Implementation of Nzeb is coming as part of new regulations regarding energy performance.

5. The fundamental competences for Building Information Modelling (BIM

In the previous paragraphs a description of digital competences for each technology and for each phase of the building process was described. This chapter is instead devoted to identifying those competences that are needed by anybody, both in the private and public sector, to fully understand the use and the advantages of digitalization in any domain and sector of the building industry.

For the identification of competences needed for the digitalization of the supply chain we refer to the work done by buildingSMART International.

The Professional Certification Program exists to support training organisations to deliver internationally standardised and recognized training content. buildingSMART International (bSI) is not, and will not become, a training organisation.

However, bSI will, through the Professional Certification Program

1. Supports the standardization of openBIM training content.
2. Provides a registration mechanism for training organisations.
3. Enables the testing and qualification of individuals (who have undertaken these approved trainings).

Additionally, the Program:

4. Promotes international standards, processes and best practices.
5. Promotes buildingSMART, its standards and solutions
6. Positions buildingSMART as a global brand and assurance of quality.
7. Create a revenue stream for Chapters and buildingSMART International.

The Program is divided into two levels. Level 1, Foundation, is the first release of the Program that focusses on knowledge-based learning. The Foundation level was developed based on the successful education Program from bSI Norway. In September 2017 this Program was officially launched by bSI and is now being adopted and implemented by Chapters around the world.

For the scope of this report, we consider only “foundation” as the main aim of the ARISE project is on energy performance and on the use of BIM to improve it.

Content Development: Professional Certification – Foundation is delivered in multiple curricula. There are currently nine curricula planned.

And one of this is energy performance. The Basic Curriculum is the foundation of the Program and is mandatory for all Chapters to adopt.

Each curriculum is defined by the following three resources:

1 The Learning Outcome Framework (LOF), which defines the course learning objectives.

2 The Body of Knowledge (BoK), a resource that describes the content (references) of each learning objective. (The BoK is an important reference for Training Provers to develop their courses.)

3 The Question Database, to populate the Qualification Platform for Student exams. Chapters who implement the Program cannot change the core learning content however, they can add additional local content to meet national standards or requirements.

Any Provider offering an extended Curriculum must also offer the Basic Curriculum.

5.6. The Basic Curriculum.

In the following table the Learning Outcome framework for the basic knowledge. It is divided, to remain with "our vocabulary", in macro and micro competences.

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Competences needed	Associated micro competences
Understand what BIM is, why it is needed, and recognize its specific terminology	Define the drivers that have led to BIM
	Define BIM
	Identify & define key BIM terminology
	Define BIM maturity levels
	Define what constitutes an Information Model
Recognize the advantages of BIM compared to traditional project delivery	Know why collaborative and new ways of working are required
	Identify the effects of poor information management on projects
	Identify the process and standards developed to mitigate poor information
	Identify the benefits of BIM for design and construction professionals
	Identify the benefits of BIM for facility owner and operators.
Understand the project information management, with BIM, according to the ISO 19650 series.	Understand why appointing parties need to clearly define their requirements
	Understand the content and value of a BIM Execution Plan (BEP)
	Know why consistent exchanges of information are required
	Identify the key elements and benefits of using a Common Data Environment (CDE)
	Know why clearly defined information management roles are required
	Know why assessing potential supply chain members before

	appointment is required.
Recognize the need for open and interoperable solutions	Know what buildingSMART is and what it represents
	Define openBIM and its benefits compared to using proprietary solutions
	Know what IFC is, and its benefits
	Know what MVDs are, and their benefits
	Know what IDMs are, and their benefits
	Know what the bSDD is, and its benefits
	Know what BCF is, and its benefits.
Understand the terms and measures of BIM capability within an organization	Understand the potential benefits for a company in adopting BIM
	Understand the factors that define an organizations level of BIM Maturity
	Know why BIM adoption needs to align to Organizational goals
	Identify the benefits and challenges to BIM adoption
	Know what the data security implications are for adopting BIM

5.7. BIM for energy performance

This activity started within the Net-UBIEP project coordinated by Anna Moreno when still working at ENEA. Since she was retired, she is now working full time for the Italian chapter of buildingSMART and the fundamental qualification on BIM and energy performance is going to become in a few months, accepted in all the countries.
As for the previous buildingSMART Module, also this has developed a Learning Outcome Framework based on five stages of the building process. For each phase the focus is on the information that need to be exchanged to reach the best energy performance.

Competences needed	Associated micro competences
Understand the context around existing conditions modelling for energy performance analysis.	Summarize the advantages of using BIM for considering existing conditions for developing new and/or refurbished building.
	Summarize standards to be used for documenting existing conditions when developing Building Information Models for new and/or refurbished building
	Understand which information about existing conditions is necessary to specify, produce, exchange, maintain, and/or update during the existing conditions analysis
	Summarize available technologies for identifying and documenting existing conditions when developing Building Information Models for new and/or refurbished building

	Specify strategies to optimize energy consumption, while preserving health, safety and comfort of building occupants and users
	Summarize the benefits of including energy performance requests in Exchange Information Requirements (EIR) for ISO 19650 and templates of EIR
	Outline the importance of identifying local and national legislation before performing the energy analysis
Summarize the specific activities to enable BIM to improve energy performance during the preliminary design stage.	Explain the advantages of using BIM for improving the energy performance of a building during its lifecycle, compared to traditional methods
	Understand the benefits of including energy requirements when developing a BIM Execution Plan (BEP).
	Summarize use cases for energy efficiency in the preliminary design stage for both new and renovation projects.
	List the specific standards necessary for specifying, producing, exchanging, and maintaining information during the preliminary design stage
	Specify the advantages of a BIM-based simulation for a cost / benefit analysis within a preliminary design of a building.
	Summarize the main actors and/or roles engaged in the production, exchange, and maintenance of information in the BIM – based workflow
Understand information requirements (e.g., specification, production, exchange, and maintenance). for a BIM – based technical design stage of energy efficient buildings.	Specify information exchange-based use cases for the technical design of energy efficient buildings
	Understand the use of code checking to facilitate the automatic control of the standards requirements (i.e., U and R values, thermal coefficient, windows / wall ratio, etc.)
	List the standards necessary for specifying, producing, exchanging, and maintaining information for energy analysis during the technical design stage.
	Summarize the geometric and alphanumeric information, as well as exchanges needed to meet energy efficiency requirements.
	Specify the information that need to be required within the Exchange Information Requirements to have an energy efficient building
	Summarize how the Common Data Environment (CDE) and other collaboration solutions systems are utilized to obtain an energy efficient building during its lifecycle.
	Summarize BIM tools and advantages compared to traditional methods that enable high quality, energy efficient technical design of buildings.

Understand information requirements for the construction stage of energy efficient buildings - specification, production, exchange, and maintenance, based on a BIM work process.	Explain the role and importance of construction stage to minimize the performance gap between the designed and achieved energy performance
	Summarize information management requirements for energy efficient construction
	Identify the standards necessary for specifying, producing, exchanging, and maintaining information to achieve energy efficient buildings during the construction stage.
	Identify requirements, roles, and responsibilities for the CDE and other information management processes for meeting energy efficiency performance during the construction phase
	Identify the most relevant information and information exchange for quality assurance and quality control during the construction stage, to achieve the designed energy performance and minimize performance gap.
	Summarize a range of technologies to meet high energy performance building and other sustainability requirements during the construction stage.
	Explain the most appropriate handover strategies, including information within BIM as built design, to promote energy efficient management of buildings and explain the purpose of information in a BIM "As Built" Design.
	List standards, procedures, and technologies to implement and manage the collection of "As-built" geometry, information, and documentation
Understand energy management at the operational stage of energy efficient buildings, enabled by BIM - principles, tools, and methods for smart energy management.	Summarize use cases for energy efficient management of buildings at the operational stage.
	Identify the information requirements and standards for openBIM© information exchange for energy efficient facility management.
	Identify a range of technologies and methods for optimization of the maintenance stage to promote targeted energy performance.
	Explain advantages and benefits (in energy and monetary terms) of using correct information and information exchange procedures to optimize facility management and maintenance based on BIM as built model
	Identify the correct information required for the disposal of any component to transfer to landfill or for reuse.

Digitalization implementation		
	Legislation requirements	**Note on the use of BUS projects**
Denmark		
Ireland	BIM mandate for the Irish public sector is not in place, despite a government strategy to increase use of Digital Technology in Key Public Works Projects launched in 2017	Not found
Italy	It is compulsory to require digital models in public procurement for large projects. In 2025 it would be always compulsory	The Net-UBIEP project has provided the basis for the qualification systems for digital competences. The buildingSMART fundamental qualification has been proposed and starts to be used
North Macedonia	It is not in force yet, although there is interest from industry to apply it.	
Netherland	n/a	Recently the Dutch chapter of buildingSMART has been reorganised. They collaborate with program DigiVaardig on digitisation in construction.
Portugal	There is no BIM Mandate in Portugal. Although the development and application of framework for BIM implementation is ongoing, and a possible upcoming BIM Mandate could be brought in in near future. THe planning service equivalent has a digital files submission policy that dates back from the early 2000s. Those being in PDF and DWG formats. No mandatory submission of BIM models. There is no prescriptive requirements in relation to digitalisation and BIM specifically for the energy efficiency area	The buildingSMART Portuguese chapter has been recently formed. There are ongoing discussions on the development and provision of training. Unclear at the moment if BUS projects will be taken in consideration
UK	BIM Mandate for the Public sector was implemented in the UK in 2016. This aligned the previous Government Soft Landing (GDL) strategy	Not found details, however may be worth noting as a related matter that many of the EU commission funded projects have been particularly developed and used in the UK. The BIMcert project trailas and training was deployed in the UK (among other regions)

	UK Government has required with the Mandate fully collaborative 3D BIM (electronic l project and asset information, documentation and data) since 2016.Procurement contracts were amended to include the requirement of BIM provision, in preparation for the Mandate, eg: in 2011 the JCT (Joint Contracts Tribunal) first published a Public Sector Supplement with introduction of a brief BIM-related amendment. An equivalent amendment was published by the The Scottish equivalent, SBCC (Scottish Building Contracts Committee), also in 2011. in the 2016 edition of the JCT 2016 edition incorporated and extended these provisions in the 2016 edition of the JCT form. However, none of these are specific in relation to BIM nor digitalisation in the specific nor exclusive use relating to energy efficiency. Planning service now request planning applications ot be submitted digitally in digital form	

6. Conclusion

The huge effort made through the CINEA Buildupskills initiative can be better capitalized for the benefit of the whole communities of member states. More workers could have the opportunity to increase their competences and work in any European country in the field they show to be competent. Enterprises will increase their business opportunities thanks to the increased capability of their workforce. Owners, both public and private will have a better return on investment due to works well performed and the end users of the buildings will live in a more comfortable house decreasing the energy cost, the environment will be healthier due to the decrease of CO2, the public health will be better thanks to the decrease of the pollution and to a better comfort both at home, in the office, in the public areas.

All this can be achieved for BIM-skills necessary for effective digitisation of the construction sector if the ARISE platform will be used in all the countries. During the testing campaign, different classes of end users will test the system in order to ensure the usability of the platform for any class of users. This report provides the bases for linking the European directives to the learning outcome already produced in many European projects to support the use of the platform also by public authorities involved in the authorization process.

It needs also to underline that the digitalization is not a "stand alone" domain, it is and has to be considered a new tool for the building industry and anybody needs to have specific competences to obtain the desired advantages that include, but are not limited to, the reduction of wastes, the reduction of time and cost, improvement of the performance and of the maintenance … in a few words a better built environment!