BIM-based EU -wide Standardized Qualification Framework for achieving Energy Efficiency Training

D3.4 – BIM for energy efficiency validation report

WP 3	**Leader: INES Formation**
Task 3.4	**Leader: INES Formation**
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Abbreviations

CA	Consortium Agreement
DoA	Description of the Action
GA	Grant Agreement
ICT	Information and Communication Technologies
PC	Project Coordinator
PSC	Project Steering Committee
QA	Quality Assurance
WP	Work Package
WPL	Work Package Leader
BIM	Building Information Modelling
EE	Energy Efficiency
EQF	European Qualification Framework
ToC	Table of Content
Mx	Milestone date designating the start of a given task
My	Milestone date designating the end of a given document delivery deadline
BEM	Building Energy Model
BIM	Building Information Modelling
CA	Consortium Agreement
DoA	Description of the Action
EE	Energy Efficiency
EPBD	Energy Performance Buildings Directive
EPC	Energy Performance Certificate
EQF	European Qualification Framework
GA	Grant Agreement
ICT	Information and Communication Technologies
KSC	Knowledge – Skills – Competencies

1.   Executive summary

This document, "BIM for energy efficiency validation report" is developed under the Work Package 3, "Definition and harmonization of BIMEET EQF".

Responsibilities, Roles, and Learning outcomes (LO) were defined according to the EQF recommendations at the BIMEET participating countries level in the T3.1 and T3.2. The LOs were then harmonized at the European level and used to define a qualification framework for each group of stakeholders. This was the objective of the T3.2. The current status in the participating countries has been, thereafter, evaluated to ensure that the specificities of each country would be taken under consideration in the designing of the trainings (Task T3.3).

In the final task of this third Work Package, a review of the learning outcomes by the External Expert Advisory Board (EEAB) held on the 26th of November 2019 in Brussels, is first presented (section 2).

Some of the developed BIMEET trainings, mainly in the field of BIM for energy efficiency training, are then analysed against the qualification framework proposed in the D3.2 (section 3). Four existing trainings are chosen to be analysed, one from each participating country (except Greece):

- "Le BIM pour l'efficacité énergétique des bâtiments", in France
- "BIM for construction consultants", in Finland
- "BIM in Design Construction and Operations (Post graduate qualification)", in UK
- "Le BIM pour l'efficacité énergétique des bâtiments", in Luxembourg

Curricula of these existing trainings are detailed: provider, language, content, audience, means and tools, LO,… Knowledge, Skills and Competencies related to the learning outcomes are defined according to the BIMEET qualification framework proposed in the D3.2 for each group of stakeholders. The EQF level is then defined. It is mainly related to the skill and/or competency level that each stakeholder requires to reach at the end of the training.

Finally, the deliverable discusses the new training schemes developed at the end of BIMEET project (section 4), and aiming to take into account the lessons learnt from the evaluation of the first training sessions delivered, summarised in this deliverable. These training schemes rely on e-learning as a mean to extend the community reached out by BIMEET outputs.

For example, the training "le BIM pour l'efficacité énergétique des bâtiments" was delivered within the BIMEET project several times for different stakeholders. The number of trainees to be reached according to the BIMEET proposal impact section was unfortunately not achieved. Some corrective actions have been undertaken and are reported in this deliverable. It consists of some modifications on this existing training. In fact, transforming the first and theoretical part of this training to e-learning content is expected to increase significant the number of trainees to be reached out. The second part of the training, i.e., the practical work remains performed in-class. This one consists on calculating the energy performance of a simple case study using the BIM model.

Another new training is conceived within the BIMEET project: BIM for Energy Performance Certificate (EPC). This training is composed of exclusively, e-learning contents. It aims to present benefits and importance of BIM in enhanced and accurate EPC assessments. The learner learns why developing the modelling and assessment skills are important for sustainable buildings building projects.

2. Review of learning outcomes by the BIMEET External Expert Advisory Board (EEAB)

The second BIMEET expert panel was held on November, 26th 2019 in Brussels. About 8 external experts participated to the workshop to discuss the main results produced during the second period of the BIMEET project.

The participants (experts and project partners) grouped into 3 small teams each with a BIMEET facilitator to provide feedback on the project's BIM and Energy Efficiency LOs and give insight from their countries' national strategies.

The key areas of feedback were to focus on 'model limitations' (model preparation, LO5), specifically:

- Providing tailored information for the key stakeholders and integrating feedback from them
- Should there be greater emphasis on collaboration (soft skills) LO6 to help promote dialogue between end users and designers, as well as dialogue between modeller, architect and engineer?
- Thermal bridge calculations – should they be specific LOs for this?
- Monitoring and management of buildings (e.g. data from sensors) need to be better integrated into models

The groups also suggested two new technical areas to consider extending the LOs to:

- Resilience and adaptation of buildings
- Off-site and pre-fabrication methods in new and existing buildings

Learnings outcomes defined within BIMEET project (D3.2) were discussed with the experts.

Experts noticed that the LO defined cover almost all the needs in skills improvements. They suggested to focus on the construction and maintenance stages where there is effectively a lack of information.

Table 1 summarizes the essential points to focus on for further development of learning outcomes.

Table 1: Overview of LO by the expert panel

RIBA PLAN Stage	Learning outcomes needed
Design	Effective collaboration between modeler/Architect/engineer
Construction	How to manage site waste?
	What is the role of BIM in the site manager's job?
	How to use the right information on site from the BIM model?
	How blue collars can integrate the energy efficiency dimension in their job?
Maintenance	Monitoring
	Integrate sensors in the BIM model
	How to translate other's requirements

3. Developed trainings vs qualification framework

This section aims to analyse existing BIM and building energy efficiency training, developed in the first period of BIMEET project, according to the qualification framework proposed in the deliverable D3.2.

As it was presented in the deliverable D4.1, there is about 19 trainings around BIM and Energy Efficiency of buildings (see Table 2).

Table 2: 19 trainings around BIM and Energy Efficiency

	Training provider	Title of the training course/ seminar	Content / training modules	Learning Outcomes
FRANCE	*INES Formation & Evaluation*	Le BIM au service de l'efficacité énergétique des bâtiments	- BIM methodology - Energy efficiency - BIM for energy efficiency - BIM & LCA (Life-Cycle Analysis)	*LO1* *LO2* *LO4* *LO7*
	Groupe Moniteur	Utiliser le BIM pour une rénovation énergétique efficace	- BIM assets - Integrate energy efficiency specifies - Integrate BIM as tool of energy performance	*LO2* *LO4*
		Le BIM et les contrats de performance énergétique	- Risk assessment towards the contractual commitment - BIM for energy saving measurement	*L05* *L06* *LO7*
Luxembourg	*HoT – OAI - Energieagence*	BIM & Energie – Module 1 – BIM et efficacité énergétique	- Performance énergétique des bâtiments d'habitation BIM - Certification environnementale LENOZ	*LO1* *LO2* *LO4* *LO7*
	HoT – OAI - Energieagence	BIM & Energie – Module 2 – BIM et CPE Habitation	BIM Processes for the Energy Performance Certification of residential buildings	*LO1* *LO2* *LO4* *LO7* *specific LO on EPC*
	HoT – OAI - Energieagence	BIM & Energie – Module 1 – BIM et CPE Fonctionnel	BIM Processes for the Energy Performance Certification of residential buildings	*LO1* *LO2* *LO4*

			LO7 *specific LO on EPC*
IFSB	Le BIM pour les entreprises de construction	- Why and how use BIM on site? - What are usages - What usages are useful for technical engineering, for completion, for the structural work, etc.? - How to train my staff (team leaders, works managers, workers, designers, ...) ?	*LO1* *LO2* *LO5* *LO6*
METROPOLIA UAS	BIM for construction consultants	- Introduction of BIM, uses and BIM possibilities - BIM execution planning - OpenBIM standard - BIM design applications demo - BIM applications for consultants - BIM utilization in different phases of construction	*LO1* *LO3* *LO5*
METROPOLIA UAS	Product Modeling		
METROPOLIA UAS	Applied Product Modeling		
METROPOLIA UAS	Utilization of BIM in construction		
METROPOLIA UA	CAD in HVAC design for single family house	- Building and HVAC drawing symbols - HVAC modelling application - Building service systems design modelling and analysis of ventilation, drainage, water systems and heating systems - Document generation based on the design models	*LO5* *LO8*
METROPOLIA UA	BIM n HVAC for office buildings	- BIM introduction - HVAC modelling and analysis of office building	*LO1* *LO4* *LO5* *LO6*

(The left column is a vertical label spanning the Metropolia rows: *Finland*)

			- BIM collaboration basics and tools for collaboration - Combination model, clash detection and information take-off	*LO8*
UK	University of the West of England	Building Information Modelling (BIM) in Design Construction and Operations	- BIM in Design Co-ordination - BIM in Construction Operation - BIM in Business and Practice - BIM in Operation and Maintenance Low/Zero-Impact Buildings Construction Project Management Practice Construction Contract Law Dissertation	*L01* *L02* *L03* *L04* *L05* *L06*
	University of Derby	Building Information Modelling and Project Collaboration	- Research Methods, Application and Evaluation - BIM and Integrated Project Collaboration nD BIM – Costing, Project Planning and Design Management - BIM and Sustainable Design Analysis - Advanced Parametric Design and Specification - Project Planning, Value Engineering and Risk Management - Construction Contracts and Dispute Resolution - Sustainable Architecture and Low Energy Design - Negotiated Module - Independent Scholarship (Technology)	*L01* *L02* *L03* *L04* *L05* *L06*
	Elmhurst Energy	Introduction to Building Information Modelling (BIM) Course	This one day training course highlights the medium and long term opportunities that BIM can bring to professional practices for building energy specialists, and covers the following: areas: - What is BIM - Software - Elmhurst and BIM - BIM impact - Issues, barriers and solutions - The future of BIM - Case studies - The energy assessment industry	*L01* *L02* *L04* *L06* *L07*
	Birmingham City University	Building Information Modelling (BIM) and Management	Develop the capability to integrate construction project delivery processes through Building Information Modelling (BIM) and collaborative practices to promote an effective, efficient, socially responsive	*L01* *L03* *L06* *L07*

			and sustainable construction industry. Develop into a construction professional for the new digital age by providing capacity required to lead and assist digital developments of the industry.	
	University of the West of England	Building Information Modelling (BIM) in Design Construction and Operations	BIM in Design Co-ordination BIM in Construction Operation BIM in Business and Practice BIM in Operation and Maintenance Low/Zero-Impact Buildings Construction Project Management Practice Construction Contract Law Dissertation	L01 L02 L03 L04 L06 L07
	Northumbria University	Building Design Management and Building Information Modelling (BIM)	To provide a better understanding of the future of construction and how the industry will develop in a BIM enabled future To provide an understanding of the complexity of working in interdisciplinary teams and managing collaborative design and production To allow students to develop new skills which will enhance their ability to plan and execute design for construction, producing more efficient, sustainable and buildable projects To allow construction industry professionals to enhance their existing skills in order to improve project delivery through the use of Building Information Modelling and Management. To foster leadership, decision making, strategic thinking and communication	L01 L03 L06 L07

In this section, four of these trainings will be analysed according to the qualification framework proposed in the D3.2. The curriculum of the training is defined and the K-S-C according to each learning outcome are detailed.

Results from D3.2 and D3.3 are used to validate the proposed qualification framework for each group of stakeholders on existing training.

3.1 "BIM for construction consultants" training

Training	Provider	Contact	Language	Audience	Pre-requisities	Content	Duration		Tools and means	Evaluation
BIM for construction consultants	Metropolia	Paivi Javaja	Fi	C, Bc		- Introduction of BIM, uses and BIM possibilities - BIM execution planning -OpenBIM standard - BIM design applications demo -BIM applications for consultants - BIM utilization in different phases of construction	11,5 days	In-class	Lessons, workshops, assignments (e.g. BIM Execution Plan). Short introduction of coordination and collaboration tools : Solibri, Trimble Connect	
	Learning Outcomes	**Knowledge**				**Skills**		**Competencies**		**EQF level**

	LO1 Learner is able to explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle.	General good knowledge about national guidelines for building information modelling (COBIM) and about BIM process and BIM technologies and their uses during the life cycle of the building.	Basic skills in ICT and BIM based project applications, Open BIM and information exchange between applications.	Competence to use knowledge and skills to - clarify the BIM-related tasks, responsibilities and obligations to each party - support the owner in decision making - study and collect user needs - define the modelling goals, uses, schedules and quality control method	5 – 6
	LO3 Learner is able to prepare BIM execution plan and explain essential aspects in setting strategic and project targets	Understanding about the importance of systematic modelling and data management.	Use of BIM compatible tools.	Competence to use knowledge and skills to - support the owner in strategic requirement setting - acquisition of designers and contractors - call for tenders negotiating and making agreements design control	5-6

	LO5 Learner is able to explain and use BIM based collaboration methods for project management and processes	Knowledge about the methods of collaboration between all project stakeholders.	Excellent general skills in communication and BIM-based collaboration. Use of CAVE, Big room and other collaborative methods of working.	Competence to use knowledge and skills to - manage BIM-project in general: design, execute, supervise	5-6

LO1	Knowledge	Skills	Competencies	EQF level
C	General good knowledge about national guidelines for building information modelling (COBIM) and about BIM process and BIM technologies and their uses during the life cycle of the building.	Basic skills in ICT and BIM based project applications, Open BIM and information exchange between applications	study and collect user needs support the owner in decision making	5
BC			clarify the BIM-related tasks, responsibilities and obligations to each party define the modelling goals, uses, schedules and quality control method	6

LO3	Knowledge	Skills	Competencies	EQF level
C	Understanding about the importance of systematic modelling and data management.	Use of BIM compatible tools.	support the owner in strategic requirement setting call for tenders negotiating and making agreements design control	6
BC			acquisition of designers and contractors	4

LO5	Knowledge	Skills	Competencies	EQF level
C	Knowledge about the methods of collaboration between all project stakeholders.		- manage BIM-project in general: design, execute, supervise	3
BC		Excellent general skills in communication and BIM-based collaboration. Use of CAVE, Big room and other collaborative methods of working.		5

3.2 BIM in Design Construction and Operations (Post graduate qualification)

Training BIM in	Provider	Contact	Language	Audience	Pre-requisites	Content	Duration		Tools and means	Evaluation
Design Construction and Operations (Post graduate qualification)	University of West England (UWE) Bristol	UWE	En	C, Bc	Honours degree of 2.2 or above in a built environment subject, or if in a different subject, with built environment experience	- BIM in Design Co-ordination - BIM in Construction Operation - BIM in Business and Practice - BIM in Operation and Maintenance - Low/Zero-Impact Buildings - Construction Project Management Practice Construction Contract Law	1 year full-time, 2 to 3 years part-time	In-class and self-study	• Lectures • Seminars • Tutorials • Project supervision • Demonstration • Workshop Software: AutoDesk Revit and Naviswork	Exam and dissertation
	Learning Outcomes	**Knowledge**				**Skills**		**Competencies**		**EQF level**

	LO1 Learner is able to explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle.	General good knowledge about national guidelines for building information modelling (COBIM) and about BIM process and BIM technologies and their uses during the life cycle of the building	Basic skills in ICT and BIM based project applications, Open BIM and information exchange between applications	Competence to use knowledge and skills to: • clarify the BIM-related tasks, responsibilities and obligations to each party • support the owner in decision making • study and collect user needs define the modelling goals, uses, schedules and quality control method	4 − 6

	LO2 Learner is able to explain the fundamentals of sustainable and energy-efficient buildings and building performance	• Define terminology and principles of energy efficiency Know about energy issues, thermal regulations, national framework of incentives measures, energy certification, sustainability schemes	• Identify and explain the suitable issues for a sustainable building • Explain the potentials of different BIM-compatible assessment, simulation and optimization tools in achieving good energy and building performance • Describe the aspects (financial and environmental) and related indicators of energy and sustainability performance • Explain relations between life-cycle costs, energy performance and building performance • Illustrate the potential of renewable energy sources including district-scale solutions Explain the core concepts of sustainable building rating and certification systems	Competence to use knowledge and skills to: • clarify the BIM-related tasks, responsibilities and obligations of each party • support the owner in decision making • study and collect user needs • define the modelling goals, uses, schedules and quality control method • Take initiative and responsibility for being on track with sustainable building	3-5

LO3 Learner is able to prepare BIM execution plan and explain essential aspects in setting strategic and project targets	Understanding about the importance of systematic modelling and data management	Use of BIM compatible tools	Competence to use knowledge and skills to: • support the owner in strategic requirement setting and legal commitments • acquisition of designers and contractors • call for tenders negotiating and making agreements design control	4-6
LO4 Learner is able to explain about the procedures and importance of setting targets for energy, sustainability and building performance	Know targets for energy, sustainability and building performance	• Explain different types of objectives, targeted outcomes and different constraints and issues for building projects Assess potentials, feasibility and risks of different alternatives based on studies performed by consultants	Take initiative to propose improvements in energy efficiency and sustainability ratings of buildings	3-6
LO5 Learner is able to explain and use BIM based collaboration methods for project management and processes	Knowledge about the methods of collaboration between all project stakeholders	• Excellent general skills in communication and BIM-based collaboration • Use of collaborative methods (and tools) of working	Competence to use knowledge and skills to: - manage BIM-project in general: design, execute, supervise	3-5

	LO6 Learner is able to explain, implement and supervise quality management procedures in building project to achieve set targets.	Knowledge of: • quality management tools and standards • project management tools and techniques commissioning processes	• Excellent general skills in communication and project and quality management	Ability to integrate: • project manager skills to achieve energy and sustainability targets, client objectives and successful commissioning BIM into facilities management	3-5

LO1	Knowledge	Skills	Competencies	EQF level
C	General good knowledge about national guidelines for building information modelling (COBIM) and about BIM process and BIM technologies and their uses during the life cycle of the building	Basic skills in ICT and BIM based project applications, Open BIM and information exchange between applications	• Study and collect user needs • Support the owner in decision making	**5**
BC			• Clarify the BIM-related tasks, responsibilities and obligations to each party • Define the modelling goals, uses, schedules and quality control method	**6**

LO2	Knowledge	Skills	Competencies	EQF level
C	• Define terminology and principles of energy efficiency • Know about energy issues, thermal regulations, National framework of incentives measures, energy	• Identify and explain the suitable issues for a sustainable building • Describe the aspects (financial and environmental) and related indicators of energy and sustainability performance • Explain relations between life-cycle costs, energy performance and building performance	• Clarify the BIM-related tasks, responsibilities and obligations of each party • Support the owner in decision making • Study and collect user needs	**4**

				EQF level
	certification, sustainability schemes	• Explain the core concepts of sustainable building rating and certification systems		
BC		• Illustrate the potential of renewable energy sources including district-scale solutions • Explain the potentials of different BIM-compatible assessment, simulation and optimization tools in achieving good energy and building performance	• Define the modelling goals, uses, schedules and quality control method • Take initiative and responsibility for being on track with sustainable building	6

LO3	Knowledge	Skills	Competencies	EQF level
C	Understanding about the importance of systematic modelling and data management	Use of BIM compatible tools	• Support the owner in strategic requirement setting and legal commitments • Call for tenders negotiating and making agreements • Design control	6
BC			Acquisition of designers and contractors	4

LO4	Knowledge	Skills	Competencies	EQF level
C	Know targets for energy, sustainability and building performance Know targets for energy, sustainability and building performance	• Explain different types of objectives, targeted outcomes and different constraints and issues for building projects • Explain different types of objectives, targeted outcomes and different constraints and issues for building projects	• Take initiative to propose improvements in energy efficiency and sustainability ratings of buildings	6

		Assess potentials, feasibility and risks of different alternatives based on studies performed by consultants		4
BC				

LO5	Knowledge	Skills	Competencies	EQF level
C	Knowledge about the methods of collaboration between all project stakeholders.		Manage BIM-project in general: design, execute, supervise	3
BC		• Excellent general skills in communication and BIM-based collaboration • Use of collaborative methods (and tools) of working		5

LO6	Knowledge	Skills	Competencies	EQF level
C	• Quality management tools and standards • Project management tools and techniques • Commissioning processes	Excellent general skills in communication and project and quality management		3
BC			Ability to integrate project manager skills to achieve energy and sustainability targets, client objectives and successful commissioning	5

3.3 "Le BIM pour l'efficacité énergétique des bâtiments" training

Training	Provider	Contact	Language	Audience	Pre-requisities	Content	Duration		Tools and means	Evaluation
Le BIM pour l'efficacité énergétique des bâtiments "BIM for Energy Efficiency of Buildings"	INES Formation & Evaluation	Donia Marzougui	Fr	C, BM, BC, Bc, CD, ARCH, ASS	-Basic knowledge in BIM -Basic knowledge in energy efficiency of buildings	- BIM Process - Energy efficiency of buildings - How to manage a BIM project? - BIM for energy efficiency - Compute energy efficiency on a BIM model using BIM software (3D modelling and energy modelling)	3 days	In-class	- ppt -practical work on BIM software (Revit and Pléiades)	MCQ (Multiple Choice Question)
	Learning Outcomes	**Knowledge**				**Skills**			**Competencies**	**EQF level**
	LO1 Learner is able to explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle.	General good knowledge about national guidelines for building information modelling (COBIM) and about BIM process and BIM technologies and their uses during the life cycle of the building.				- Basic skills in ICT and BIM based project applications, Open BIM and information exchange between applications - Explain the added value of using open formats (interoperability)			Competence to use knowledge and skills to - clarify the BIM-related tasks, responsibilities and obligations to each party - support the owner in decision making - study and collect user needs - define the modelling goals, uses, schedules and quality control method	

| | | LO2

Learner is able to explain the fundamentals of sustainable and energy-efficient buildings and building performance | - Define terminology and principles of energy efficiency
- Know about energy issues thermal regulations, National framework of incentives measures energy certifications | - Identify and explain the suitable issues for a sustainable building
- Explain the potentials of different BIM-compatible assessment, simulation and optimization tools in achieving good energy and building performance
- Describe the aspects (financial and environmental) and related indicators of energy and building performance
- Explain relations between life-cycle costs, energy performance and building performance
- illustrate the potentials of renewable energy sources including district-scale solutions
- explain the core concepts of sustainable building rating and certification systems | Competence to use knowledge and skills to
- clarify the BIM-related tasks, responsibilities and obligations to each party
- support the owner in decision making
- study and collect user needs
- define the modelling goals, uses, schedules and quality control method

- Take initiative and responsibility for being on track with sustainable building | |
| | | LO4

Learner is able to explain about the procedures and importance of setting targets for energy sustainability and building performance | Know targets for energy, sustainability and building performance | - Explain different types of objectives, targeted outcomes and different constraints and issues for building projects.
- Assess potentials, feasibility and risks of different alternatives based on studies performed by consultants | Take initiative to propose improvements in energy efficiency of buildings | |

| | LO7

Learner is able to use different relevant software and interfaces between relevant software | Know the utility of different BIM software | - Use BIM software and explain the added values of these interoperable software
- Explain the added values of interoperability
- Explain BIM model requirements to be well imported in an energy computation software | - Lead the process resulting in the publication of the merged model (as designed) together with all needed information to support sustainable procurement, construction and maintenance
- Lead the design team to prepare, compare and improve alternative concepts
- Direct the design towards set targets utilizing the capacity of different kinds of digital assessment and simulation methods. | |

LO1	Knowledge	Skills		Competencies		EQF level
C	General good knowledge about national guidelines for building information modelling (COBIM) and about BIM process and BIM technologies and their uses during the life cycle of the building.	- Basic skills in ICT and BIM based project applications, Open BIM and information exchange between applications		study and collect user needs support the owner in decision making		4
BM			- Explain the added value of using open formats (interoperability)		clarify the BIM-related tasks, responsibilities and obligations to each party define the modelling goals, uses, schedules and quality control method	6
BC						5
Bc						4
CD			- Explain the added value of using open formats (interoperability)		clarify the BIM-related tasks, responsibilities and obligations to each party define the modelling goals, uses, schedules and quality control method	6
ARCH						6
ASS						3

LO2	Knowledge	Skills		Competencies		EQF level
C	Define terminology and principles of energy efficiency Know about energy issues thermal regulations, National framework of incentives measures energy certifications	Identify and explain the suitable issues for a sustainable building Describe the aspects (financial and environmental) and related indicators of energy and building performance - Explain relations between life-cycle costs, energy performance and building performance		support the owner in decision making study and collect user needs	Take initiative and responsibility for being on track with sustainable building define the modelling goals, uses, schedules and quality control method - clarify the BIM-related tasks, responsibilities and obligations to each party	4
BM						3
BC						3
Bc			explain the core concepts of sustainable building rating and certification systems illustrate the potentials of renewable energy sources including district-scale solutions			5
CD						4
ARCH			Explain the potentials of different BIM-compatible simulation and optimization tools in achieving good energy and building performance		Take initiative and responsibility for being on track with sustainable building define the modelling goals, uses, schedules and quality control method - clarify the BIM-related tasks, responsibilities and obligations to each party	6
ASS						2

LO4	Knowledge	Skills		Competencies		EQF level
C	Know targets for energy, sustainability and building performance	Explain how to define requirements for performance documentation (how and where the targeted, designed and achieved performance is documented to enable the continuous monitoring by the client).	Explain different types of objectives, targeted outcomes and different constraints and issues for building projects Use risk analysis and conduct feasibility (financial and technical) studies to make sure set objectives of the project are achievable	Take initiative to propose improvements in energy efficiency of buildings Clarify the BIM-related tasks, responsibilities and obligations to each party		6
BM						6
BC						5
Bc			Assess potentials, feasibility and risks of different alternatives based on studies performed by consultants			6
CD			Produce, simulate and analyze what if scenarios for different energy efficient design alternatives and make feasibility studies based on the domain knowledge. Consider options of renewable energy in architectural design and optimize its potentials Implement passive house design strategies for architectural design			5
ARCH						6
ASS						2

LO7	K	S		C		EQF level
C	Know the utility of different BIM software			Take initiative to propose improvements in energy efficiency of buildings		4
BM		Use BIM software and explain the added values of interoperable software			Lead the process resulting in the publication of the merged model (as designed) together with all needed information to support sustainable procurement, construction and maintenance Lead the design team to prepare, compare and improve alternative concepts - Direct the design towards set targets utilizing the capacity of different kinds of digital assessment and simulation methods.	5
BC						5
Bc						5
CD		Use different tools for BIM-based collaborative working. Use visualization tools, viewers and dashboards Explain the added values of interoperability - Explain BIM model requirements to be well imported in an energy computation software	Extract energy analyses parameters from BIM to BEM for simulations and import results to BIM			5
ARCH						5
ASS						3

This last training was delivered 9 times since 2018 for different audience. Details are in the Table 3.

Table 3: List of sessions insured by INES according to the training "Le BIM pour l'efficacité énergétique des bâtiments"

When?	For who?	How many persons?	How many days?
February 2018	Trainers of the French national education	18	3
October 2018	Professionals: ARCH, CD, ASS, BM, BC, C	14	1
2018 – 2019 – 2020	Students from ENSAM (Ecole des Arts et Métiers) and USLB (Université Savoie Mont-Blanc)	40	4
2018 – 2020	Professionals: site managers on energy efficiency	12	0,5

"Le BIM pour l'efficacité énergétique des bâtiments" was delivered for about 85 participants since 2018.

Let's for example analyse in details the program training delivered for the students of Savoie Mont Blanc University. The "BIM for energy efficiency of buildings" module is integrated in the *Mastère spécialisé* (specialised master) "Construction et Habitat Durable" (sustainable constructions) of *Ecole des Arts et Métiers* in *Chambéry*. Students have different profiles (architects and engineers) and an equivalent qualification level of 6 and 7. The full program of this module is described in Table 4.

Table 4: Full program of the module "BIM for energy efficiency of buildings" of the specialised master "Construction et Habitat Durables" in Chambéry

Day 1	Introduction to BIM	Definition Levels of development Maturity levels BIM objects BIM software BIM for the existing projects Interoperability How to integrate a BIM workflow in a construction project
	Practical work	Conceive a simple individual house on Revit
Day 2	Introduction to Energy efficiency of buildings	Heat losses Heat gains Heating needs Bioclimatic envelope How to improve energy efficiency of buildings

	Practical work	Export the BIM to IFC/gbXML Import the exported model in Pléiades Compute heating needs and energy consumption of the project
Day 3	BIM management	Regulations BIM team BIM manager roles BIM management tools and software CDE (Common Data Environment)
	Practical work	Work on some BIM models on Revit
Day 4	BIM for energy efficiency of buildings	BIM to BEM workflows Introduction to building LCA (in a BIM workflow)
	Practical work	Building LCA on the BIM model

At the end of this training, students aim the roles of BIM manager, BIM coordinator, architect and energy engineer. EQF levels of 6 and 7 are then targeted.

Figure 1 analyses the learning outcomes covered according to the training content.
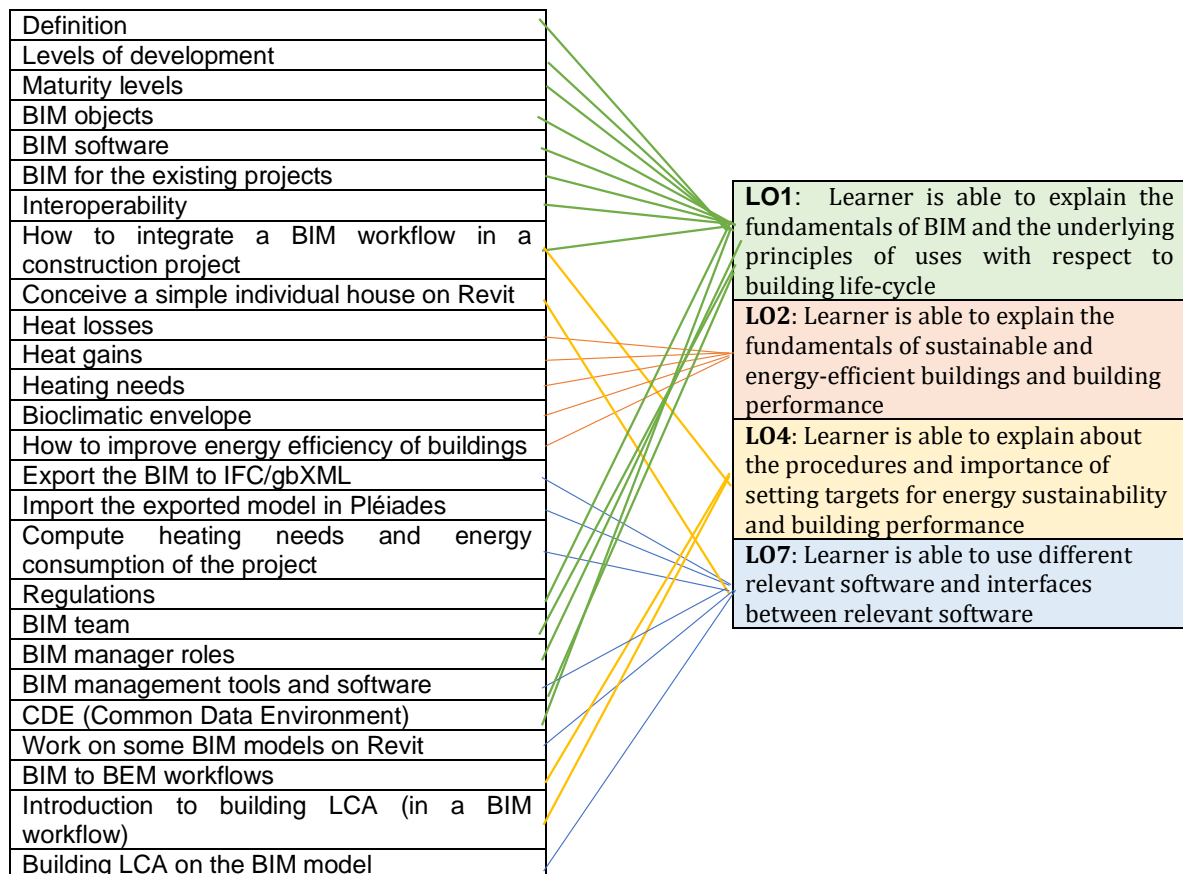

Figure 1: LO covered according to the content of the BIM&EE training

4.   New BIMEET training

Section 4 describes the training modules that have been designed in the later stage of BIMEET action. The consortium decided to build on the lessons learnt in the first steps of the project in order to improve existing training schemes or deliver knowledge based on the research carried out within BIMEET.

Two courses are therefore presented in the following parts.

4.1   BIM and Building Energy Efficiency – blended learning scheme

As it was presented in section 3, The *BIM for building energy efficiency* training was delivered several times and about 85 persons were trained. This is not sufficient to reduce the potential energy saving. That's why we have to increase the number of trained persons. One issue is to transform the in-class training to a blended learning scheme as it is described in Figure 2.

OBJECTIVE OF THE COURSE

Learner gets a coherent overview of BIM and building energy efficiency. (S)he understands the benefits and importance of BIM in enhanced and accurate results of energy efficiency. (S)he also learns what needs to be considered in the information modelling to unleash its potential as the data source for the analysis. An overview of some use cases helps the learner to understand the benefits and challenges of current tools. An in-class practical work consists on understanding some BIM tools and dealing with interoperability issues. Modules of this training can be followed separately.

TARGET GROUP

All stakeholders in the building industry could be interested on this training, especially Architectural design roles and energy design roles. This BIM&EE training may also interest client roles to be aware of the BIM potential for energy efficiency training.

DETAILS OF THE TRAINING

A placement test is required before beginning the training. Here we come to some fundamental questions to assess knowledge typically required of trainees for BIM on the one hand and energy efficiency on the other.

The scores of this placement test permit to customize the in-class training content to best suit the trainees' level.

Three e-learning courses are proposed. These ones deal with theoretical contents about:

- Introduction to BIM
- Introduction to energy efficiency of buildings
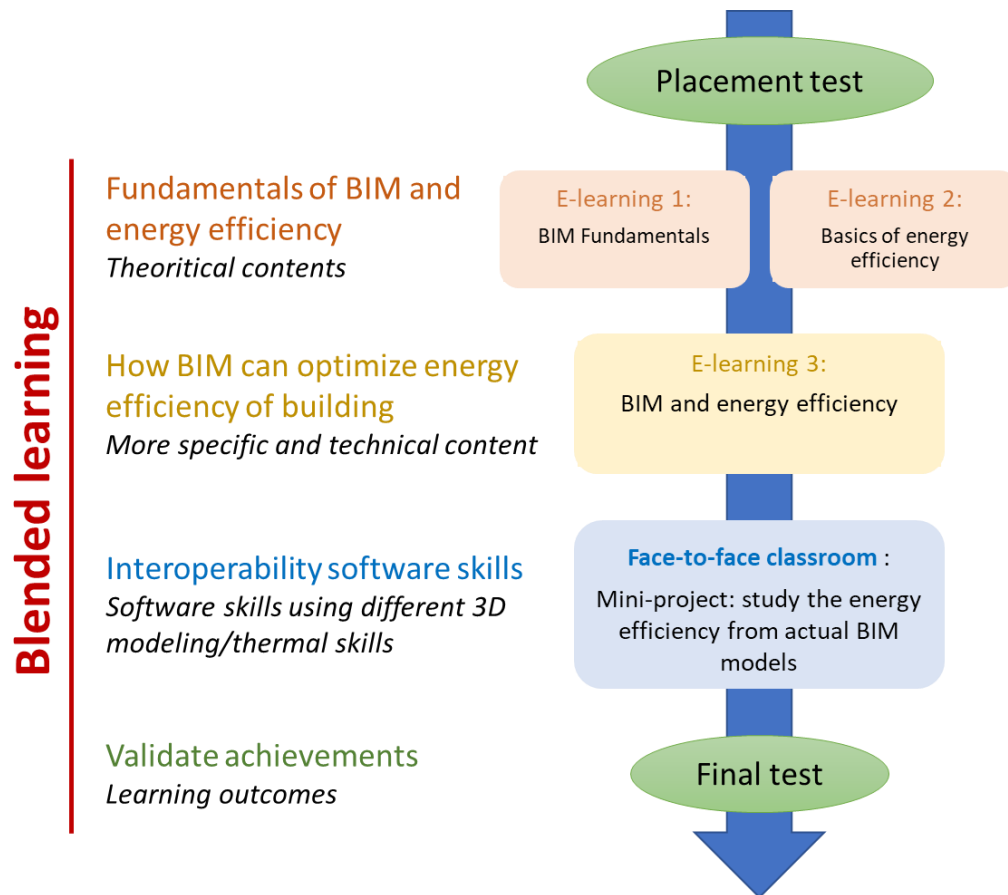- How BIM can optimize energy efficiency of buildings

Figure 2: Blended learning scheme for BIM and Building Energy Efficiency training

The following Table 5, Table 6, Table 7 and Table 8 present details of these three e-learning courses and the in-class one.

Table 5: Description of module 1 - introduction to BIM

Module 1: Introduction to BIM		
Learning outcomes	- Learner is able to explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle - Learner is able to explain and use BIM based collaboration methods for project management and processes - Learner is able to explain basic objectives of using BIM during different stages of the building - Learner is able to prove comprehensive knowledge about BIM terminology, definitions and national guidelines for building information modelling	
Content	Chapter 1 What is BIM	Definition of BIM BIM potentials

	Chapter 2 BIM levels	Level of maturity Level of development Dimensions of BIM
	Chapter 3 How BIM works	Closed and Open BIM Interoperability A BIM team
Duration	13 minutes	

Table 6: Description of module 2 - introduction to energy efficiency of buildings

Module 2: Introduction to Energy Efficiency of Buildings		
Learning outcomes	- Learner is able to explain the fundamentals of sustainable and energy-efficient buildings and building performance - Learner is able to prove good knowledge on over all energy efficiency of buildings and excellent knowledge on profession specific demands in achieving energy efficient buildings	
Content	Chapter 1 Introduction	- Energy context - Thermal flows: conduction, convection and radiation
	Chapter 2 Heat losses	- Thermal resistance - How to compute heat losses through opaque surfaces, air infiltration, air renewal, windows and thermal bridges
	Chapter 3 Heat gains	- Solar gains - Internal gains How to compute heating needs
	Chapter 4 How to improve energy efficiency	- How to reduce heating demand - How to improve air tightness and reduce ventilation losses - How to improve the insulation of buildings - How to reduce cooling demand
Duration	20 minutes	

Table 7: Description of module 3 - BIM for Energy Efficiency of Buildings

Module 3: BIM for Energy Efficiency of Buildings		
Learning outcomes	- Learner is able to explain about the procedures and importance of setting targets for energy, sustainability and building performance - Learner is able to implement energy performance, building performance and sustainability targets into design process is able to create and develop sustainable energy efficient buildings using BIM tools - Learner is able to explain the aspects how BIM based projects benefit energy efficient buildings. - Learner is able to prove skills in using BIM-based design software	
Content	Chapter 1 Introduction	- Common BIM - How BIM can optimize energy efficiency through the whole life cycle
	Chapter 2 BIM for energy efficiency of construction	- In programming phase - In design phase - In construction phase - In use and exploitation phase
	Chapter 3 Use cases	- Green O'Valley: buildings by Schneider Electric in Grenoble - Development of a virtual city model, 3D model of Dundalk
Duration	9 minutes	

Following these e-learning contents, about 2 days of in-class training are delivered. The aim is:

- To discuss with the trainee, if there is some questions about what it was followed remotely.
- To use BIM software: perform a thermal simulation on a 3D model (Revit for 3D modelling and Pléiades for energy computation)

The practical work is performed on a simple case study (two rooms individual house for example). Interoperability issues are raised when exporting the 3D model and importing it to the energy computation software.

Details of this in-class training are in the Table 8.

Table 8: Description of module 4: Thermal simulation on a BIM model

Module 4: Practical work – Thermal simulation using a BIM model	
Learning outcomes	- Learner is able to use different relevant software and interfaces between relevant software - Learner is able to understand and correct interoperability errors - Learner is able to prove skills in using BIM-based design software - Learner is able to produce BIM models with accurate and required information content for different uses and phases of a building project - Learner is able to produce different design concepts and make feasibility comparisons with help of simulations to achieve targets set by client - Learner is able to perform different analysis in using assessment, simulation and optimisation tools - Learner is able to explain how to define resources needed for design and defining competence requirements for designers and engineers
Content	- Design 3D model on Revit: simple 2 rooms individual house - Export 3D model to IFC or gbXML model - Import the exported model in a thermal simulation software (Pléiades for example) - Simulate the energy behaviour of the model: compute heating needs and energy consumption
Duration	14 hours

QUALIFICATION FRAMEWORK

The analysis of this BIM&EE training according to the qualification framework proposed in D3.2 is presented in Table 9 and Table 10 for the different stakeholders who followed the training.

Table 9: BIMEET Qualification Framework for Client and Client advisors' roles corresponding to the BIM&EE training

No	Learning outcome	EQF level

Client & Client advisors Client & Project manager (C), BIM manager (BM), BIM coordinator (BC), briefing consultant (Bc)	C	BM	BC	Bc
LO1 **Learner is able to explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle.**	**4**	**6**	**6**	**4**
1.1 Recall essential contents, summarize and give examples of BIM terminologies, definitions and standards.	4	6	5	4
1.2 Explain added value of BIM for energy efficient and sustainable projects.	4	6	5	5
1.3 Explain the potentials of different BIM-compatible assessment, simulation and optimization tools in achieving good energy and building performance.	2	3	3	5
1.5 Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	3	5	5	2
1.6 Explain the main contents and apply relevant parts of national BIM guidelines.	4	6	5	-
LO2 **Learner is able to explain the fundamentals of sustainable and energy-efficient buildings and building performance.**	**3**	**3**	**3**	**5**
2.1 Explain and give examples of aspects and terminology related to energy and building performance.	4	4	4	3
2.2 Describe the aspects (financial and environmental) and related indicators of energy and building performance.	5	4	4	3
LO4 **Learner is able to explain about the procedures and importance of setting targets for energy, sustainability and building performance.**	**6**	**5**	**3**	**6**
4.2 Include and explain the importance of energy analysis in the decision making starting from the earliest stages of the project and even on the basis of very simple and preliminary BIMs.	6	4	2	6
4.5 Review BIM models and evaluate the functionality of spaces with regard to user needs, designed performance and set performance targets.	4	5	4	5
4.7 Explain the concepts of digital twin and its potential in the optimization of comfort and energy performance of building.	3	3	3	1
4.8 Explain how to define requirements for performance documentation (how and where the targeted, designed and achieved performance is documented to enable the continuous monitoring by the client?).	4	6	4	-
LO7 **Learner is able to use different relevant software and interfaces between relevant software.**	**4**	**5**	**5**	**5**

7.3	Use different tools for BIM-based collaborative working.	3	5	5	3
7.4	Use BIM compatible requirement setting tools.	4	3	3	5
7.5	Prepare and maintain the requirement model.	-	4	4	3
7.6	Create combination model and use model checking tools for design reviews and constructability.	-	3	5	-

Table 10: BIMEET Qualification Framework for Architectural design roles corresponding to the BIM&EE training

No	Learning outcome	EQF level		
Architectural design roles Architectural design and BIM Coordinator (arch), Chief designer (CD), Architect (ARCH), Assistant designer (ASS)		CD	ARCH	ASS
LO1	Learner is able to explain the fundamentals of BIM and the underlying principles of uses with respect to building life-cycle.	6	6	3
LO2	Learner is able to explain the fundamentals of sustainable and energy-efficient buildings and building performance.	4	6	2
LO4	Learner is able to implement energy performance, building performance and sustainability targets into design process.	5	6	1
LO5	Learner is able to produce BIM models with accurate and required information content for different uses and phases of a building project.	3	6	2
LO8	Learner is able to use different relevant software and interfaces between relevant software.	5	5	3

4.2   BIM for Energy Performance Certificate (EPC) – e-learning training

Another new training was designed within BIMEET project: *BIM for Energy Performance Certificate* which is a full e-learning training.

Assessing EPC (Energy Performance Certificate) is mandatory for most buildings in the EU. EPC has the potential to direct construction projects towards sustainable solutions. The traditional way of generating EPC can be time consuming. BIM (Building Information Modeling) is becoming a more popular information source during building projects and building life cycle. BIM is a virtual data-bank of the building and has the potential to excessively enhance the EPC process. An energy efficient building is based of integrated effort and knowledge of a variety of different stakeholders, and course can be beneficial to anyone working in the construction sector.

Each country in the EU has their own approach to EPC and BIM. During the course, learner is able to follow course materials according to their country perspective or introduce themselves the developments of other countries. Course consists of slideshows, videos, extra-materials and final exam.

LEARNING OUTCOMES

The learning outcomes defined for BIM to EPC course training is as follows. Additional learning outcomes matrix developed in the project was further consulted for defining module specific learning objectives that are listed in the next heading.

- Explain added value of BIM for energy efficient and sustainable projects.
- Explain the potentials of different BIM-compatible assessment, simulation and optimization tools in achieving good energy and building performance.
- Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.
- List and explain the core concepts of sustainable building rating and certification systems.
- Explain and give aspects and terminologies of energy and building performance.
- Point out legislation and regulations related to energy performance, thermal comfort and air quality.

OBJECTIVE OF THE COURSE

Learner gets a coherent overview of current and future uses of EPC in the building sector in the EU. (S)he understands the benefits and importance of BIM in enhanced and accurate results of EPC assessments. (S)he also learns what needs to be considered in the information modelling to unleash its potential as the data source for the analysis. An overview of different use cases helps the learner to understand the benefits and challenges of current tools. Overview of the future developments of BIM and EPC presses the importance of developing modelling and assessment skills for better quality building projects.

At the end of the training, the learner is able to:

- Point out legislation and regulations related to EPC (Energy Performance Certificates).
- List and explain core concepts of EPC (Energy Performance Certificate) in the EU.
- List and explain core concepts assessment.
- List initial data needed for EPC assessment.
- Give examples of specific information modeling requirements and outputs to enhance EPC assessment.
- Give examples how to extract needed initial data from BIM for EPC.
- Summarize the process of EPC calculation.
- Discuss about potentials and uses of different available BIM-compatible EPC-tools.

TARGET GROUP

This online course is contributing to the national approach, it is open to all stakeholders in the building industry with special benefit to Clients & Client advisors, Architectural design roles and Building services design roles. Learners are able to follow course materials according to their country perspective or introduce the developments of other countries.

DETAILS OF THE TRAINING

The training is composed of 5 lessons and a final exam to validate the learning outcomes as it follows (Figure 3):

- Lesson 1: Review of (2018) Regulations
- Lesson 2: Added value and possibilities of BIM for EPC assessment
- Lesson 3: How to prepare BIM and how to extract data from bim for EPC
- Lesson 4: EPC calculation tools and use cases
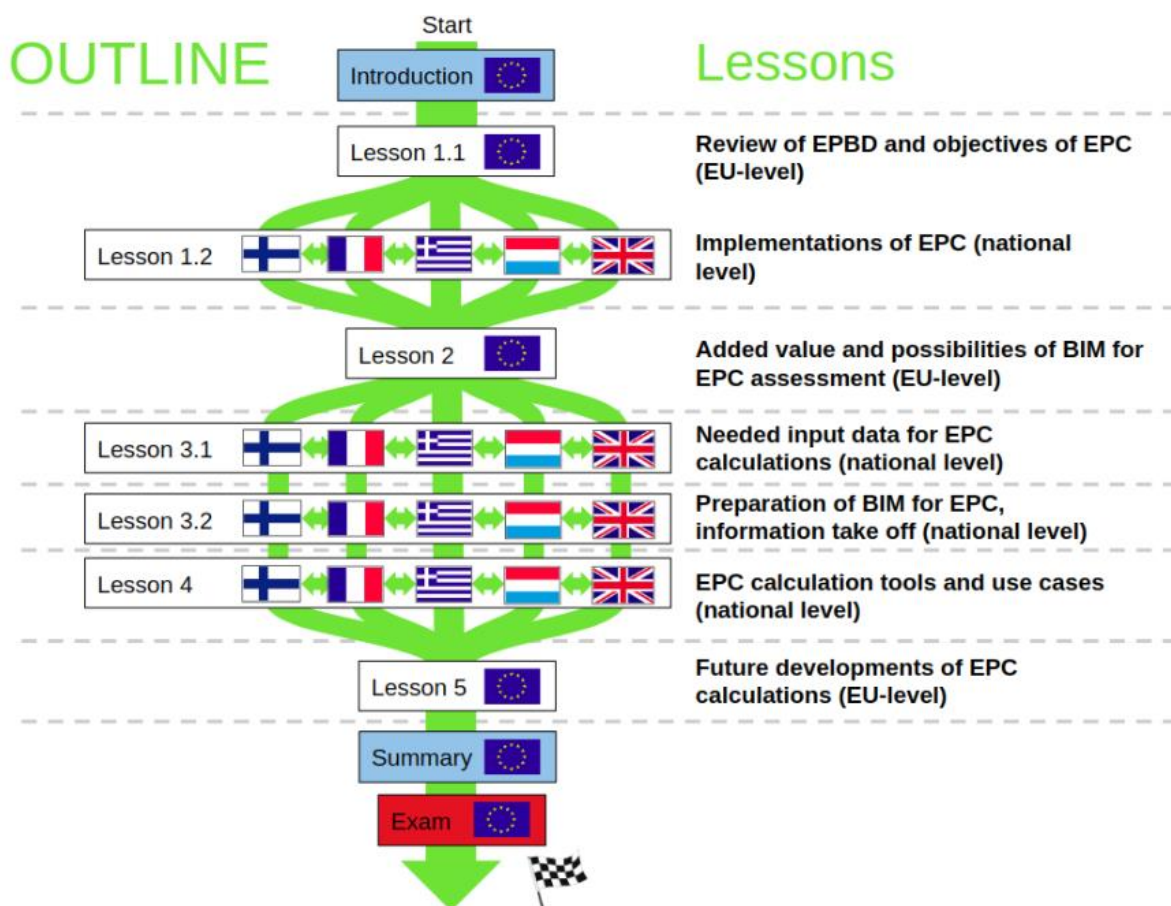- Lesson 5: Future developments of EPC calculations and BIM

Figure 3: BIM for EPC training scheme

Details of lessons are in Table 11, Table 12, Table 13, Table 14 and Table 15.

Table 11: description of Lesson 1 - Review of EPC in Europe

Lesson 1 – Review of EPC in Europe	
Learning Objectives	- The learner is able to point out legislation and regulations related to EPC

	- The learner is able to list and explain core concepts of EPC in the EU.
Content	- General review of EPBD and objectives of EPC in the EU - National implementations of EPC: Finland, UK and Luxembourg perspectives
Duration	15 minutes

Table 12: Description of lesson 2 - Added value of BIM in EPC assessment

Lesson 2 – Added value of BIM in EPC assessment	
Learning Objectives	- The learner is able to explain added value of BIM for EPC assessment.
Content	- EPC in building energy analysis - EPC calculations - Interoperability - Collaborative approaches - How to enable BIM benefits in EPC assessment?
Duration	10 minutes

Table 13: Description of lesson 3 - How to prepare BIM and how to extract data from BIM to EPC

Lesson 3 – How to prepare BIM and how to extract data from BIM to EPC	
Learning Objectives	- Learner is able to list initial data needed for EPC assessment. - Learner is able to give examples of specific information modelling requirements and outputs to enhance EPC assessment. - Learner is able to give examples how to extract needed initial data from BIM for EPC.
Content	- National implementations of data required for EPC calculations (Finland, UK) - Preparation of BIM to benefit EPC and information take off (Finland)
Duration	20 minutes

Table 14: Description of lesson 4 - EPC tools, processes and software

Lesson 4 – EPC tools, processes and software		
Learning Objectives	- Learner is able to summarize the process of EPC calculation. - Learner is able to explain about potentials and uses of different available BIM-compatible EPC-tools.	
Content	EPC tools, processes and software	- Finland perspective - UK perspective
	Use cases/Animated demos	- EPC assessment in monthly method with – Laskentapalvelut.fi - How to make light 3D-model to enhance EPC assessment – SketchUp - How to import IFC file to dynamic calculation tool – IDA Indoor Climate and Energy
Duration	23 minutes	

Table 15: Description of lesson 5 - Future developments of EPC calculations and BIM

Lesson 5 – Future developments of EPC calculations and BIM	
Learning Objectives	- The learner is able to discuss about the future developments of EPC.
Content	- Next generation of EPC - Integration with BIM models - Benefits of building EPC database - Quality control - Recommendations
Duration	5 minutes

QUALIFICATION FRAMEWORK

Learning outcomes of this BIM for EPC calculations training according to the qualification framework proposed in D3.2 are presented in Table 16, Table 17, Table 18, Table 19, Table 20 and Table 21 for the different stakeholders who followed the training.

Table 16: BIMEET Qualification Framework for Client roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level			
	Client & Client advisors Client & Project manager (C), BIM manager (BM), BIM coordinator (BC), briefing consultant (Bc)	C	BM	BC	Bc
1.2	Explain added value of BIM for energy efficient and sustainable projects.	4	6	5	5
1.3	Explain the potentials of different BIM-compatible assessment, simulation and optimization tools in achieving good energy and building performance.	2	3	3	5
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	3	5	5	2
1.6	Explain the main contents and apply relevant parts of national BIM guidelines.	4	6	5	-
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	4	4	4	3
2.5	List and explain the core concepts of sustainable building rating and certification systems.	3	3	3	5

Table 17: BIMEET Qualification Framework for architectural design roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level		
	Architectural design roles Architectural design and BIM Coordinator (arch), Chief designer (CD), Architect (ARCH), Assistant designer (ASS)	CD	ARCH	ASS
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	5	5	2
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	6	6	2
2.5	List and explain the core concepts of sustainable building rating and certification systems.	4	4	2

2.7	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	6	6	3

Table 18: BIMEET Qualification Framework for structural design roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level	
		SD	ASS
Structural design roles Structural design (SD) and BIM Coordinator (structural), Assistant designer (ASS)			
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	5	2
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	6	2
2.5	List and explain the core concepts of sustainable building rating and certification systems.	4	1
2,7	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	5	2

Table 19: BIMEET Qualification Framework for building services design roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level	
		HVAC+E	ASS
Building services design roles HVAC and energy design (HVAC+E) and BIM Coordinator (HVAC), Assistant designer (ASS)			
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	5	2
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	5	2
2.5	List and explain the core concepts of sustainable building rating and certification systems.	5	2

2.7	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	6	2

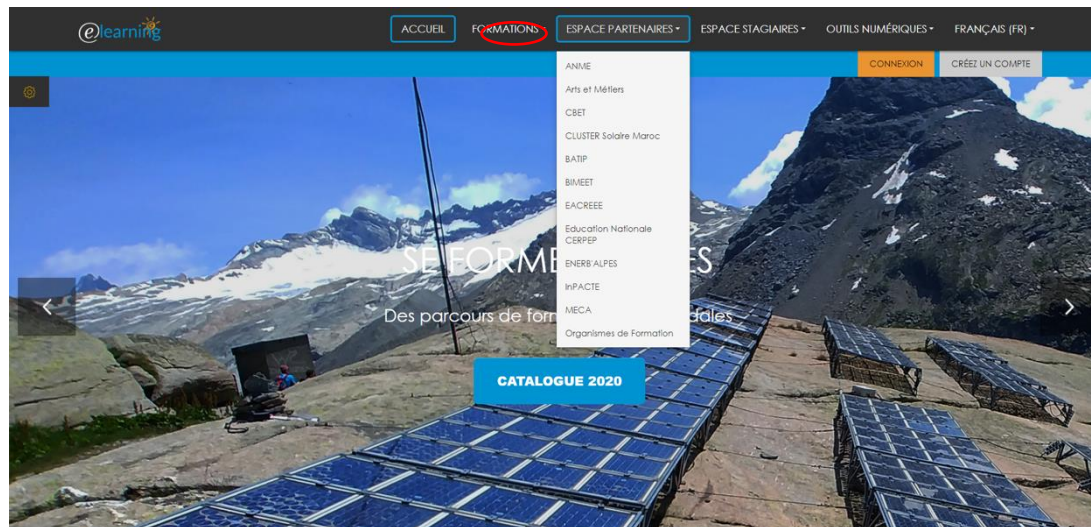Table 20: BIMEET Qualification Framework for construction work roles corresponding to the BIM&EPC training

No	Learning outcome	EQF level	
Construction work roles Site manager (SM), Construction site workers and installers (CW)		SM	CW
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	4	-
2.5	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	4	-

Table 21: BIMEET Qualification Framework for maintenance work roles corresponding to the BIM&EPC training

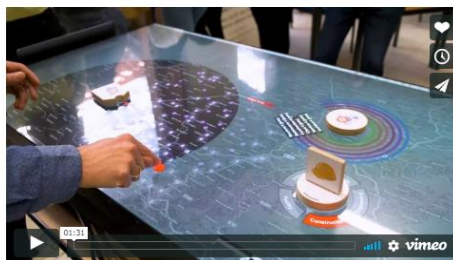| No	Learning outcome	EQF level		
Maintenance work roles Maintenance operator (MO), Property manager (PM), Care taker (CT)		MO	PM	CT
2.1	Explain and give examples of aspects and terminology related to energy and building performance.	3	3	1
2.6	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	3	2	2

4.3   How to get to courses

From www.energy-bim.com, and from the e-learning training widget, you have a summary of the training and some other information like the overview of the course, target group, learning objectives, duration, and the access to the contents of courses. These ones are hosted in INES e-learning platform (www.e-learning.ines-solaire.org)(Figure 4).

Figure 4: BIMEET trainings on INES platform

In order to make statistics on the numbers of trainings' followers and their profiles, an account registration is mandatory to have access to the courses.

5. Conclusions

This report analyses some existing trainings delivered in the participating countries according to the proposed BIMEET qualification framework.

The curriculum of the training "BIM for energy efficiency of buildings" delivered in France is presented in details. Learning outcomes and their related knowledge, skills and competencies are analysed. EQF level of each learning outcome for each stakeholder is presented in this deliverable on the basis of what it was defined in D3.2, but analysed according to the label framework in D5.3.

Modifications on these trainings have been proposed, mainly in order to increase the number of trainees and thus the impact of our BIMEET action. In fact, the "BIM for energy efficiency" training is transformed to a *blended learning* scheme. The learner can therefore follow the first part, i.e., theoretical content of the course remotely (e-learning videos). In-class practice exercise follows the e-learning part, and allow the learner to practically use BIM software to compute energy consumption of the building using the BIM model.

Another new *full e-learning* training is proposed. It concerns BIM for EPC (Energy Performance Certificate), and is built on prior research work[1] carried out within D3.2 and other BIMEET tasks. It consists of an overview of current and future uses of EPC in the EU building sector and a presentation of the benefits of BIM in enhanced and accurate results of EPC assessments.

In conclusions, we were able within the BIMEET project to perform three trainings in the field of BIM for energy efficiency of buildings:

- BIM for energy efficiency of buildings (***In-class***)
- BIM for energy efficiency of buildings (***Blended learning***)
- BIM for Energy Performance Certificate (***e-learning***)

The e-learning content is on-line and accessible from our BIMEET platform www.energy-bim.com.

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[1] Some of these outputs have been published in a research publication: Y. Li, S. Kubicki, A. Guerriero, Y. Rezgui. Review of building energy performance certification schemes towards future improvement. *Renewable and Sustainable Energy Reviews*. Volume 113, 2019, ISSN 1364-0321, https://doi.org/10.1016/j.rser.2019.109244.