



# LEARNING OUTCOMES

---

**VTT**

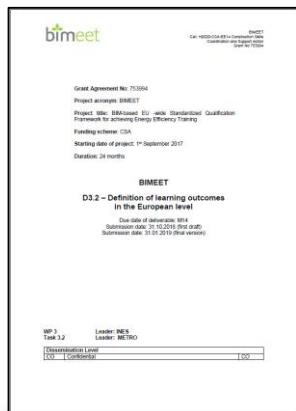
**TARJA MÄKELÄINEN**

BIMEET  
Expert Panel Workshop, November 26<sup>th</sup>, 2019



# CONTENT

- LO development in BIMEET
- Different roles and S-K-C
- BIMEET LO tables
- Next steps



Report D3.2 – Definition of learning outcomes in the European level



# BIMEET- EU HORIZON 2020 PROJECT, WHICH EMPHASIZES ENERGY-EFFICIENCY MANAGEMENT OF BUILDINGS WITH THE HELP OF IMPROVED BIM SKILLS.



**The project focuses on creation and implementation qualification and training schemes for building professionals and blue collar workers.**

**<https://www.vtt.fi/sites/bimeet>**

BIMEET, BIM-based EU-wide standardized qualification framework for achieving energy efficiency training, EU H2020, Grant agreement No 753994.

# BIM FOR ENERGY MANAGEMENT

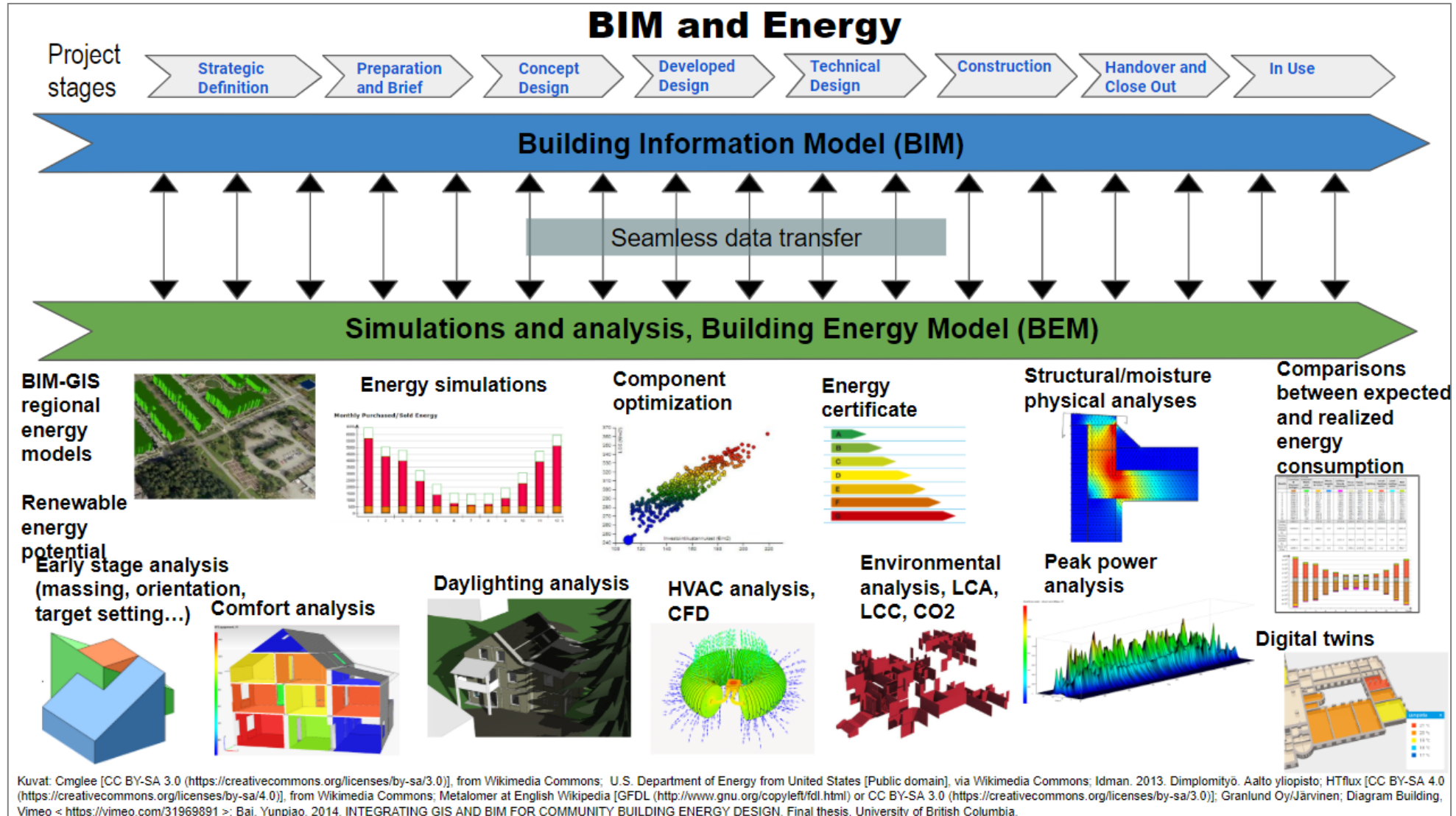


Image: (CC-BY 4.0) Eksergia.fi – Open Web School of Energy Efficient Buildings

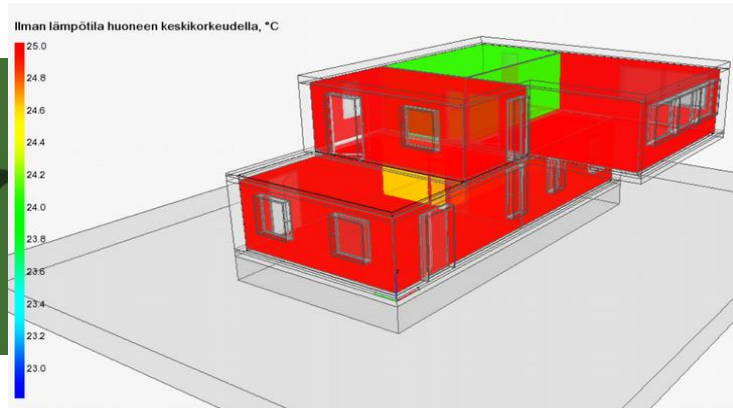
# BIM FOR ENERGY KNOWLEDGE MANAGEMENT

Development process included several steps:

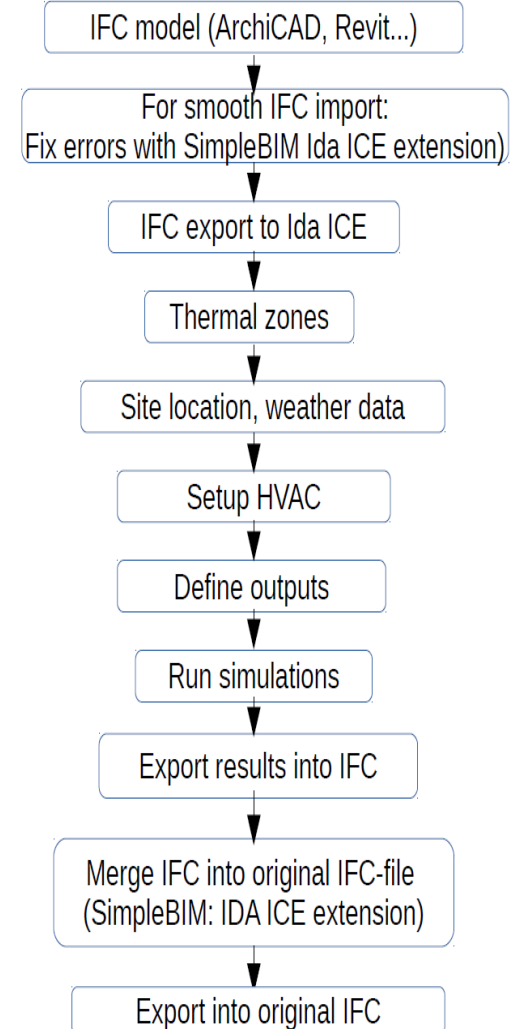
- BIM + EE Case studies
- Inquiries to experts
- Tests of different tools (BIM->BEM->BIM)
- Existing BIM + EE courses
- Harvesting Twitter with algorithms
- **Development of S-K-C and Learning outcomes**



**BIM to BEM:  
TESTING IDA-ICE**



## Workflow



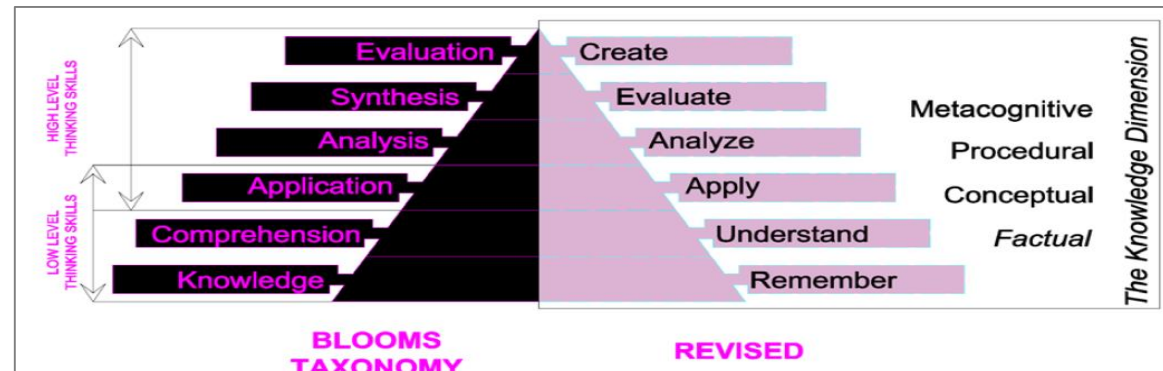


# BIMEET- LEARNING OUTCOMES

Learning outcomes are attributed to individual educational components and to programmes at a whole.

Learning outcomes are specified in three categories – as knowledge, skills and competence. This signals that qualifications – in different combinations – capture a broad scope of learning outcomes, including theoretical knowledge, practical and technical skills, and social competences where the ability to work with others will be crucial.

- Approach: Blooms taxonomy is the most often used frequent tool while developing learning outcomes

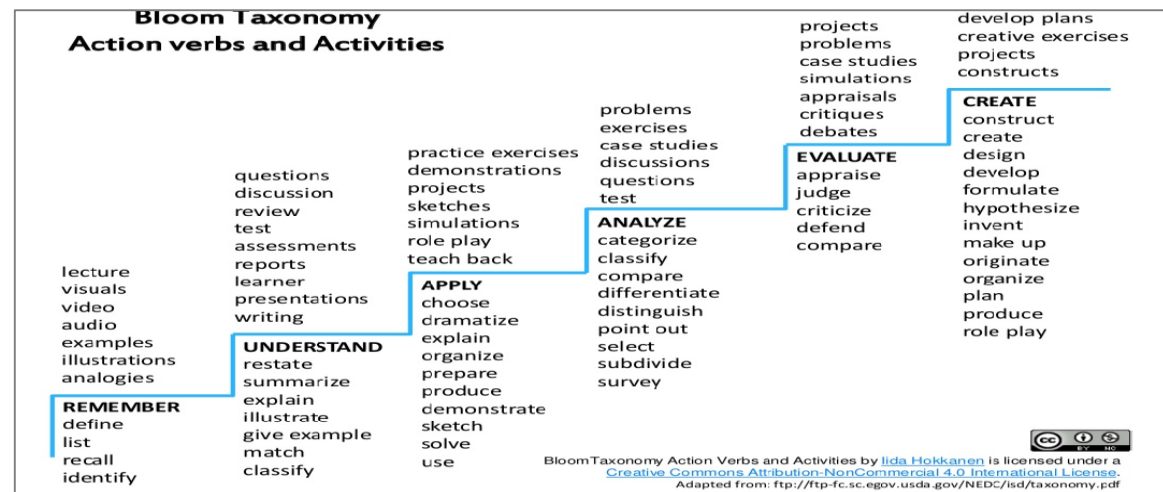


Users'Guide, E. C. T. S. "Luxembourg: Publications Office of the European Union." DOI 10 (2015): 87192.

[https://europass.cedefop.europa.eu/sites/default/files/ects-users-guide\\_en.pdf](https://europass.cedefop.europa.eu/sites/default/files/ects-users-guide_en.pdf).

Krathwohl, D. R. (2002). A revision of Bloom's taxonomy: An overview. *Theory into practice*, 41(4), 212-218. lida Hokkanen 2015:

<https://www.slideshare.net/lidaHokkanen/bloom-taxonomy-action-verbs-and-activities>



# Bloom Taxonomy

## Action verbs and Activities

### DEFINING THE LEVELS

lecture  
visuals  
video  
audio  
examples  
illustrations  
analogies

#### REMEMBER

define  
list  
recall  
identify

questions  
discussion  
review  
test  
assessments  
reports  
learner  
presentations  
writing

#### UNDERSTAND

restate  
summarize  
explain  
illustrate  
give example  
match  
classify

practice exercises  
demonstrations  
projects  
sketches  
simulations  
role play  
teach back

#### APPLY

choose  
dramatize  
explain  
organize  
prepare  
produce  
demonstrate  
sketch  
solve  
use

problems  
exercises  
case studies  
discussions  
questions  
test

#### ANALYZE

categorize  
classify  
compare  
differentiate  
distinguish  
point out  
select  
subdivide  
survey

projects  
problems  
case studies  
simulations  
appraisals  
critiques  
debates

#### EVALUATE

appraise  
judge  
criticize  
defend  
compare

develop plans  
creative exercises  
projects  
constructs

#### CREATE

construct  
create  
design  
develop  
formulate  
hypothesize  
invent  
make up  
originate  
organize  
plan  
produce  
role play

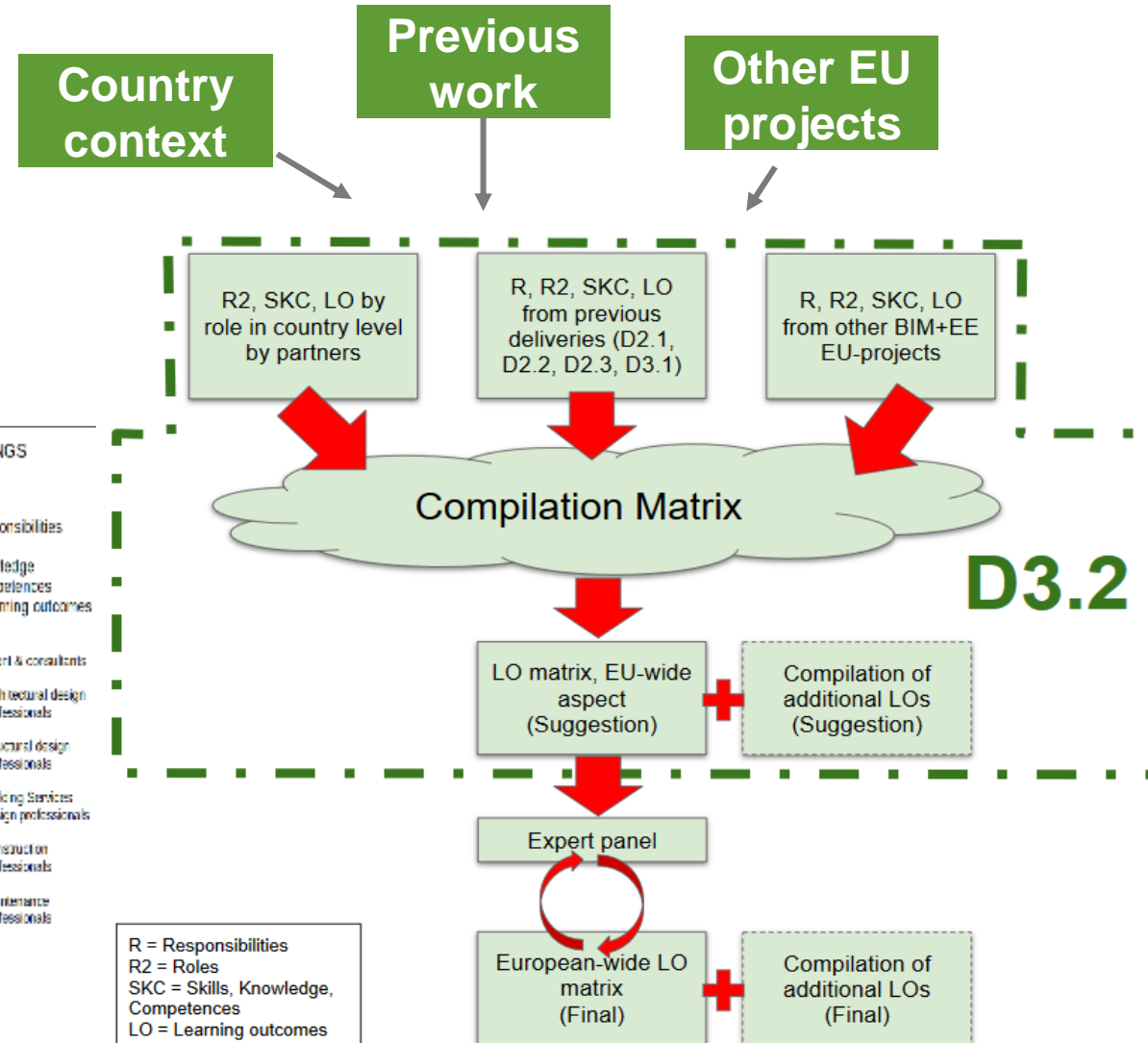
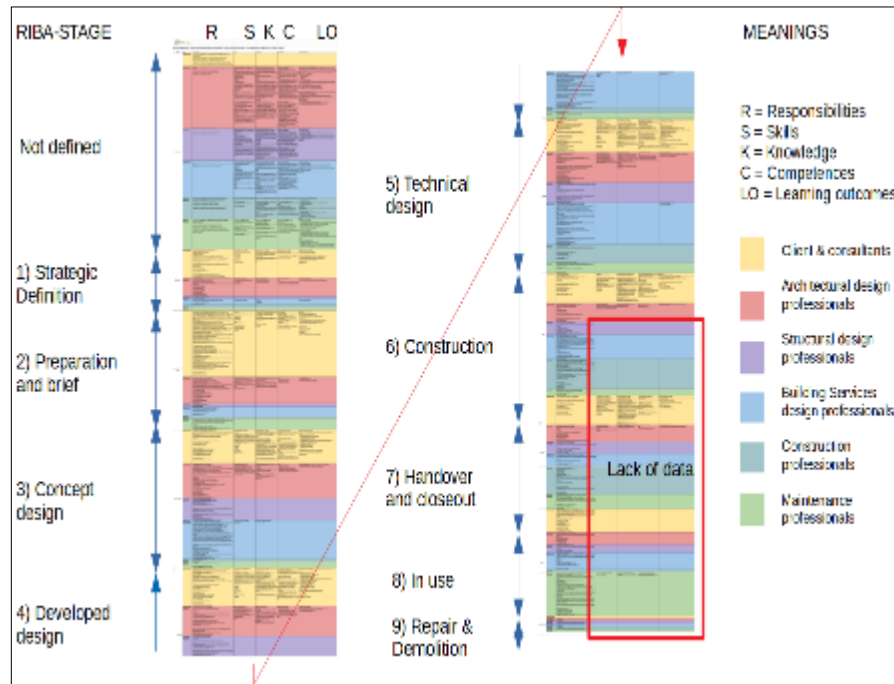


Bloom Taxonomy Action Verbs and Activities by [lida Hokkanen](#) is licensed under a [Creative Commons Attribution-NonCommercial 4.0 International License](#).

Adapted from: <ftp://ftp-fc.sc.egov.usda.gov/NEDC/isd/taxonomy.pdf>


# WORKING METHOD:

## LEARNING OUTCOMES FOR MANAGEMENT OF ENERGY EFFICIENCY IN BIM PROCESS





- Client & Clients advisors
- Architectural design roles
- Structural design roles
- Building services design roles
- Construction work roles
- Maintenance work roles

	<b>BIMEET</b> E.ON-EDITION-GAS & CO. Energy Service Gesellschaft mit beschränkter Haftung Postfach 10 D-42699 Solingen		
<p>Grant Agreement No: 773564</p> <p>Project acronym: BIMEET</p> <p>Project title: BIMEET – E.ON - eds - Standardized Qualification Framework for achieving Energy Efficiency Training</p> <p>Funding scheme: CSA</p> <p>Starting date of project: 1<sup>st</sup> September 2017</p> <p>Duration: 24 months</p>			
<h3>BIMEET</h3> <h4>D3.2 – Definition of learning outcomes in the European level</h4>			
<p>Start date of deliverable: 01/01/2018</p> <p>Submission date: 31.10.2018 (first draft)</p> <p>Submission date: 31.10.2019 (final draft)</p>			
<p>WP 1</p> <hr/> <p>Task 3.2</p>	<p>Leader: NETO</p> <hr/> <p>Leader: NETO</p> <hr/> <p>Cooperation Partner:</p> <hr/> <p>CO – 1 (partner):</p> <hr/>		
	<table border="1" style="float: right; margin-bottom: 0;"> <tr> <td style="width: 80%;"> </td> <td style="width: 20%; text-align: center;">1.00</td> </tr> </table>		1.00
	1.00		

## Report D3.2 – Definition of learning outcomes in the European level


[illegible]



# LEARNING OUTCOMES

# EXAMPLES OF S-K-C AND LOS

Required knowledge, skills and competences for the different roles in design, building and maintenance processes – defined in process stages



BIMSET  
 CME: H2020-CMA-6514 Construction Skills  
 Coordination and Support Action  
 Grant No. 703661

Table 7 European wide BIM-EE learning outcome matrix for structural design roles (i.e. Structural design and BIM coordinator (structural), Assistant designer)

Learning outcomes are defined in specific order forming eight groups:

- Group 1 (LO1) Fundamentals of BIM and principles of its use with respect to building life-cycle
- Group 2 (LO2) Fundamentals of sustainable and energy-efficient buildings and building performance
- Group 3 (LO3) Leading of design process, supporting the client and other stakeholders in decision making
- Group 4 (LO4) Implementation of energy performance, building performance and sustainability targets into design process
- Group 5 (LO5) Production of BIM models with accurate and required information content for the different uses and phases of a building project
- Group 6 (LO6) Collaboration, communication and visualization with help of BIM
- Group 7 (LO7) Implementation of target and quality management procedures in the building project
- Group 8 (LO8) Skills for relevant software and interfaces between software

bimeet		EQF level	
No.	Learning outcome		
Structural design roles			
Structural design (SD) and BIM coordinator (structural), Assistant designer (ASD)		SD	ASD
LO1	Learner is able to explain the fundamentals of BIM and the underlying principles of use with respect to building life-cycle.	6	3
1.1	Recall essential contents, summarize and give examples of BIM terminology, definitions and standards.	6	3
1.2	Recall essential contents, summarize and give examples of overall BIM processes for a building's life cycle.	6	3
1.3	Explain and use standard information exchange processes for different design domains in general and especially in detailed technical design.	5	2
1.4	Explain the essential issues related to information management, data transfer and sharing.	5	2
1.5	Explain the added value of using open file formats (i.e. IFC) to ensure interoperability.	5	2
1.6	Recall, summarize and explain essential contents and relevant parts of national BIM guidelines.	6	2
LO2	Learner is able to explain the fundamentals of sustainable and energy-efficient buildings and building performance.	6	2
2.1	Describe the financial and environmental aspects and related indicators, benchmarks and certification systems of energy and building performance.	6	2
2.2	Explain the issues that affect energy performance of buildings and can demonstrate competence in domain specific solutions.	6	1
2.3	Explain relations between life-cycle costs, environmental impacts, energy performance and building performance.	6	1
2.4	List and explain the core concepts of sustainable building rating and certification systems.	4	1
2.5	Summarize and illustrate the potentials of renewable energy sources applicable to buildings including district-scale solutions.	4	1

C2-2 BIMSET – Definition of learning outcomes in the European level

46

LO2 BIMSET - Definition of learning outcomes in the European level

46

bimeet			BIMSET CME: H2020-CMA-6514 Construction Skills Coordination and Support Action Grant No. 703661	
2.7	Point out legislation and regulations related to energy performance, thermal comfort and air quality.	5	2	
LO3	Learner is able to lead structural design team and support the client and other stakeholders in decision making.	6	-	
3.1	Explain the overall design process for energy-efficient building.	6	2	
3.2	Assist client to set realistic and achievable energy and building performance target.	4	-	
3.3	Assist the client to set and specify information requirements.	6	-	
3.4	Explain how to support owner's effective decision-making and opinion formation of other stakeholders.	5	-	
3.5	Illustrate how to direct the design towards set targets utilizing the capacity of different kinds of assessment methods relevant for structural design.	5	1	
3.6	Explain the flow of design teamwork and demonstrate how to prepare, compare and improve alternative concepts.	5	1	
3.7	Lead / assist the tasks related to technical documents (structural engineering) for the building authorities.	6	2	
LO4	Learner is able to implement energy performance, building performance and sustainability targets into design process.	6	2	
4.1	Apply the set performance targets related to structural design into BIM-based design process.	6	-	
4.2	Implement passive design strategies for structural design.	5	-	
4.3	Point out essential issues and take into consideration of the effects of airtightness, insulation, thermal bridges, characteristics of windows and shading on energy performance and building performance.	6	2	
4.4	Create different design concepts (flexible, modular, easily maintainable and recyclable structural solutions) and make feasibility studies based on the domain knowledge.	6	2	
4.5	Use relevant methods to compare alternatives and iterate structural design with regard to engineering issues and structural physics, moisture physics.	6	2	
4.6	Discuss and assess the effect of main building materials and main product type selections on energy performance and building performance to full the set targets.	6	2	
4.7	Produce, simulate and analyze what if scenarios for different energy efficient design alternatives and make feasibility studies based on the domain knowledge.	6	2	
4.8	Present and visualize the results of analyses, calculation, simulations and assessments.	6	2	
LO5	Learner is able to produce BIM models with accurate and required content for different uses and phases of a building project.	6	2	
5.1	Create domain model on the basis of set targets and definitions given in the architect's model.	6	2	
5.2	Create and update digital (BIM-based) building specification with material and dimensional information to reflect owner's quality and performance requirements.	6	2	
5.3	Explain essential issues of the needs of initial data and the potentials of different inventory surveys in refurbishment projects.	6	2	
5.4	Support the process resulting in the publication of the merged model (As-Built/Designed) together with all needed information.	6	2	
5.5	Prepare/assess data needed for specific use cases such as bill of quantities.	5	2	
5.6	Prepare/assess the domain model for simulation and assessment.	5	2	

LO2 BIMSET - Definition of learning outcomes in the European level

46

bimeet			BIMSET CME: H2020-CMA-6514 Construction Skills Coordination and Support Action Grant No. 703661	
5.7	Prepare/assess models and information for planning authority and in required data format.	5	2	
5.8	Prepare/assess models and information for procurement and construction.	5	2	
5.9	Prepare/assess models to full quality and data requirements for quality control and assurance processes in construction.	5	2	
5.10	Prepare/assess models based on data and information requirements of sustainable care and maintenance processes.	5	2	
5.11	Prepare/assess information for As-Built Models and Maintenance model for utilization of client and building management.	5	2	
5.12	Prepare/assess in the digital formulation of care maintenance instructions (maintenance manual) reflecting owner's energy and performance requirements.	5	2	
LO6	Learner is able to collaborate and use collaborative approaches to support communication and visualization.	6	2	
6.1	Describe the essential parts of the procedure for BIM based collaboration.	5	2	
6.2	Describe different collaborative interdisciplinary and open BIM working methods, tools and processes.	6	2	
6.3	Demonstrate how to work collaboratively with the project stakeholders including design team, client, users, manufacturers, construction site and building authorities.	5	2	
6.4	Prepare relevant visualization models to enable information sharing, decision making and opinion formation.	5	2	
6.5	Demonstrate the flow of design teamwork with use of void provision model together with architectural and building services design.	5	2	
6.6	Collaborate with the help of communication platforms and processes like CAVE (computer aided virtual environment) and Big Room working.	5	2	
LO7	Learner is able to explain and give examples about implementing target and quality management procedures in the building project.	5	-	
7.1	Participate/assess in systematic modeling in own organization ensuring that all information is provided in right order, right format and on agreed schedule.	5	2	
7.2	Validate and check compatibility of the domain model and manage and resolve conflict.	5	2	
7.3	Verify the achievement of the targets on the basis of the results received with the help of different kinds of assessment methods relevant for structural design.	5	-	
7.4	Participate in the verification of the achievement of the targeted result and undertake site inspections in construction site.	5	2	
7.5	Comment building product providers' designs and the impacts of contractor's selections on energy consumption to ensure the fulfillment of targets.	5	-	
7.6	Instruct and audit contractors on construction site on critical points.	5	-	
7.7	Describe and assess quality assurance methods for energy-efficient building envelope (such as blow door test, thermography) to verify achievement of set targets.	5	-	
LO8	Learner is able to use different relevant software and interfaces between relevant software.	6	3	
8.1	Use domain specific design authoring applications for structural design and analysis.	6	3	
8.2	Use relevant structural calculation and assessment tools in different design phases.	6	2	

LO2 BIMSET - Definition of learning outcomes in the European level

46

bimeet			BIMSET CME: H2020-CMA-6514 Construction Skills Coordination and Support Action Grant No. 703661	
8.3	Use different tools for BIM-based collaborative working.	5	2	
8.4	Create combination model and use model checking tools for clash detection.	5	1	
8.5	Extract energy analyses parameters from BIM to GEM for simulations and input results to BIM (material data).	4	1	
8.6	Use relevant visualization tools for visualizing energy parameters from simulations and calculations.	5	2	
8.7	Create reference model for detail simulations and assessments.	5	2	
8.8	Use project data and file management systems.	6	2	

LO2 BIMSET - Definition of learning outcomes in the European level

47

LOs for Structural designer



Example  
of S-K-C

STRUCTURAL  
ENGINEER AND  
THE S-K-C TABLE

		Skills	Knowledge	Competence	Learning outcomes
		Excellent BIM domain skills in using BIM authoring software and BIM compatible simulation tools such as skills in using TEKLA Structures and TEKLA Structural Designer. Skills in doing assessment and simulations regarding <ul style="list-style-type: none"><li>safety</li><li>service life and building physics</li><li>building structures related life cycle cost</li><li>building structures related environmental performance</li><li>overall</li></ul>	Excellent knowledge about national guidelines for building information modelling (COBIM, especially COBIM 5, 7, 10 + Appendix for Part 5). Comprehensive knowledge about BIM terminology and definitions Knowledge about the aspects of building performance and impacts (financial and environmental) and related indicators and benchmarks, labels and certificates Understanding about the feasibility with the help of different kinds of concept solutions Knowledge about the effect of structural solutions on energy performance and	Competence to use knowledge and skills <ul style="list-style-type: none"><li>to support target setting by preparing preliminary alternatives for the structural systems and by assessing effects on energy and building performance</li><li>to prepare the structural engineer's domain model with the help of architect's reference model and considering all needs for compatibility and by considering the set performance targets</li><li>to check the validity of the model and the compatibility of domain models</li><li>to prepare the model / digital data to make (BIM-compatible) relevant simulations</li></ul>	Proven ability based on exams <ul style="list-style-type: none"><li>about good theoretical knowledge in structural design and overall design principles for safe and energy-efficient buildings</li></ul> Proven ability based on demonstration <ul style="list-style-type: none"><li>about the skills in using the structural engineers' domain software and all needed assessment and simulations tests</li></ul>
	analyses Skills for BIM-based collaboration such as with the help of CAVE (computer aided virtual environment) and Big Room working Skills in using visualisation tools and preparing technical visualization images to enable good information sharing in	alternative potential solutions to fulfil the set targets. Knowledge about the potentials of different assessment, calculation and optimisation tools Understanding about BIM-based design of elements such as slabs, walls and frameworks	support the fulfilment of the set targets <ul style="list-style-type: none"><li>to support the preparing of the digital (BIM-linked) building specification to reflect owner's quality and performance requirements</li><li>to support successful element design by providing knowledge about design targets in terms of indicators</li></ul>	Proven ability based on demonstration <ul style="list-style-type: none"><li>about the skills in doing performance analyses, and improvements and in selecting the best solutions among structural system alternatives</li></ul>	
		NavisWorks - for quality assurance Skills in using project data management	different design domains in general and especially in	design team, owner/project manager, building authorities.	

## Example of LO's

# CLIENT AND CLIENT ADVISORS CLIENT & PROJECT MANAGER (C), BIM MANAGER (BM), BIM COORDINATOR (BC), BRIEFING CONSULTANT (BC)

<b>LO3</b>	<b>Learner is able to prepare BIM execution plan and explain essential aspects in setting strategic and project targets.</b>	<b>6</b>	<b>6</b>	<b>4</b>	<b>6</b>
3.1	Explain the importance and illustrate processes of collecting expectations and setting targets for building spaces, indoor environment and energy performance.	6	4	3	6
3.2	Explain the importance and illustrate processes of decision making with regard to the choice of building location, whether and when to renovate or build new.	6	3	2	6
3.3	Explain owners' strategic target setting processes to guide energy and performance requirement setting in business cases.	6	4	2	6
3.4	Explain how to identify most suitable organizational structure and range of consultants to be engaged for the project to reach the set targets and goals.	6	5	3	6
3.5	Explain and illustrate BIM process and related technologies especially in preparing the project plan based on owner's BIM strategy.	4	6	5	-
3.6	Describe the decision-making process about the use of BIM and defining modelling uses.	4	6	4	-
3.7	Demonstrate how to make process maps for the selected BIM uses and set information exchange requirements.	2	6	5	-
3.8	Explain how to define resources needed for design and defining competence requirements for designers and engineers.	4	6	4	-
3.9	Give examples how to formulate a clear definition of the BIM and EE related tasks, responsibilities and obligations to each party and implement them in calling for tenders, negotiations and agreements.	4	6	4	-
	Explain and give example how to prepare BIM execution plan for the				



## ARCHITECTURAL DESIGN ROLES

ARCHITECTURAL DESIGN AND BIM COORDINATOR (ARCH), CHIEF DESIGNER (CD), ARCHITECT (ARCH), ASSISTANT DESIGNER (ASS)

<b>LO4</b>	<b>Learner is able to implement energy performance, building performance and sustainability targets into design process.</b>	<b>5</b>	<b>6</b>	<b>1</b>
4.1	Apply the set performance targets related to architectural design into BIM-based design process.	5	6	-
4.2	Implement passive house design strategies for architectural design.	5	6	1
4.3	Point out essential issues related to consideration of the effect of position, orientation, volume and space design, and main product type selections on energy performance and building performance.	5	6	2
4.4	Explain about the principles of sustainable internal layout and flexible floorplan.	5	6	-
4.5	Consider options of renewable energy in architectural design and optimize its potentials.	4	5	-
4.6	Perform energy analyses, life cycle assessments (LCA) and life cycle cost analyses (LCC).	3	5	-
4.7	Produce, simulate and analyze what if scenarios for different energy efficient design alternatives and make feasibility studies based on the domain knowledge.	3	6	2

## STRUCTURAL DESIGN ROLES

### STRUCTURAL DESIGN (SD) AND BIM COORDINATOR (STRUCTURAL), ASSISTANT DESIGNER (ASS)

<b>LO4</b>	<b>Learner is able to implement energy performance, building performance and sustainability targets into design process.</b>	<b>6</b>	<b>2</b>
4.1	Apply the set performance targets related to structural design into BIM-based design process.	6	-
4.2	Implement passive design strategies for structural design.	5	-
4.3	Point out essential issues and take into consideration of the effects of air-tightness, insulation, thermal bridges, characteristics of windows and shading on energy performance and building performance.	6	2
4.4	Create different design concepts (flexible, modular, easily maintainable and recyclable structural solutions) and make feasibility studies based on the domain knowledge.	6	2
4.5	Use relevant methods to compare alternatives and iterate structural design with regard to engineering issues and structural physics, moisture physics.	6	2
4.6	Discuss and assess the effect of main building materials and main product type selections on energy performance and building performance to fulfil the set targets.	6	2
4.7	Produce, simulate and analyze what if scenarios for different energy efficient design alternatives and make feasibility studies based on the domain knowledge.	6	2
4.8	Present and visualize the results of analyses, calculation, simulations and assessments.	6	2

## BUILDING SERVICES DESIGN ROLES

### HVAC AND ENERGY DESIGN (HVAC+E) AND BIM COORDINATOR (HVAC), ASSISTANT DESIGNER (ASS)

LO5	Learner is able to produce BIM models with accurate and required content for different uses and phases of a building project.	5	2
	5.1 Prepare the HVAC/MEP engineer's domain model on the basis of set targets and definitions given in architect's domain model.	5	2
	5.2 Create and update digital (BIM-linked) building specification with material and dimensional information to reflect owner's quality and performance requirements.	5	2
	5.3 Explain essential issues of the needs of initial information and the potentials of different inventory surveys in refurbishment projects.	5	2
	5.4 Support the process resulting in the publication of the merged model (As-Designed) together with all needed information.	5	2
	5.5 Prepare/assist information needed for specific use cases such as bill of quantities.	5	2
	5.6 Prepare/assist the domain model for simulation and assessment.	5	2
	5.7 Prepare/assist models and information for planning authority and in required data format.	5	2
	5.8 Prepare/assist models and information for procurement and construction.	5	2
	5.9 Prepare models to fulfil quality and information requirements for quality control and assurance processes in construction.	5	2
	5.10 Prepare models based on data and information requirements of sustainable care and maintenance processes.	5	2
	5.11 Prepare information for As-Built Models and Maintenance model for utilization of client and building management.	5	2
	Prepare/assist in the digital formulation of care maintenance		

## CONSTRUCTION ROLES

CONSTRUCTION WORK ROLES SITE MANAGER (SM), CONSTRUCTION SITE WORKERS AND INSTALLERS (CW)

<b>LO8</b>	<b>Learner is able to use different relevant software and interfaces between relevant software.</b>	<b>5</b>	<b>2</b>
8.1	Use digital construction management tools and systems.	5	-
8.2	Create combination model and use model checking tools for clash detection.	5	-
8.3	Use different tools for BIM-based collaborative working.	5	-
8.4	Use tools for information take-offs from the models.	5	1
8.5	Use tools for 4D and BIM based site management plan.	5	-
8.6	Use BIM viewers with tablet devices.	4	2
8.7	Use project data and file management systems.	5	-



**MAINTENANCE ROLES**  
MAINTENANCE WORK ROLES MAINTENANCE OPERATOR (MO), PROPERTY  
MANAGER (PM), CARE TAKER (CT)

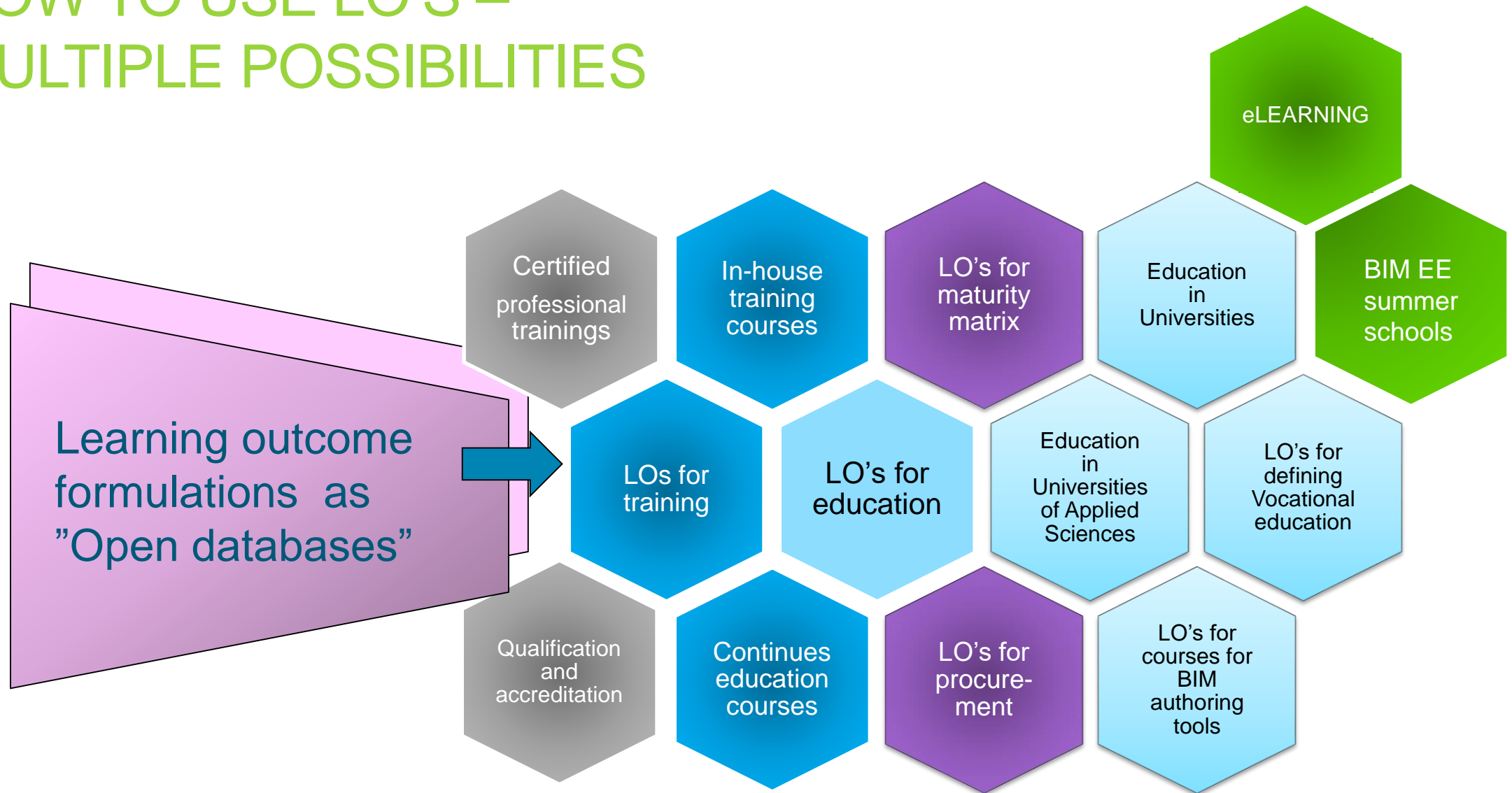
<b>LO5</b>	<b>Learner is able to implement energy performance, building performance and sustainability targets into operation and maintenance.</b>	<b>4</b>	<b>4</b>	<b>-</b>
5.1	Use BIM-compatible maintenance manual to operate buildings according to targets both in terms of comfort and energy efficiency.	4	4	-
5.2	Analyze building performance by comparing energy and indoor climate simulations to actual consumption.	4	2	-
5.3	Utilize energy analyses in case of malfunctions and in resolving their causes and comparing repair options.	4	3	-
5.4	Update energy targets of the building by calibrated energy analyses taking into account changes in the operation.	4	2	-
5.5	Collect and use customer feedback and define different principles of continuous improvement and influencing techniques.	3	4	-
5.6	Explain and give examples how to use monitored digital operational data in continuous energy and performance management	4	2	-

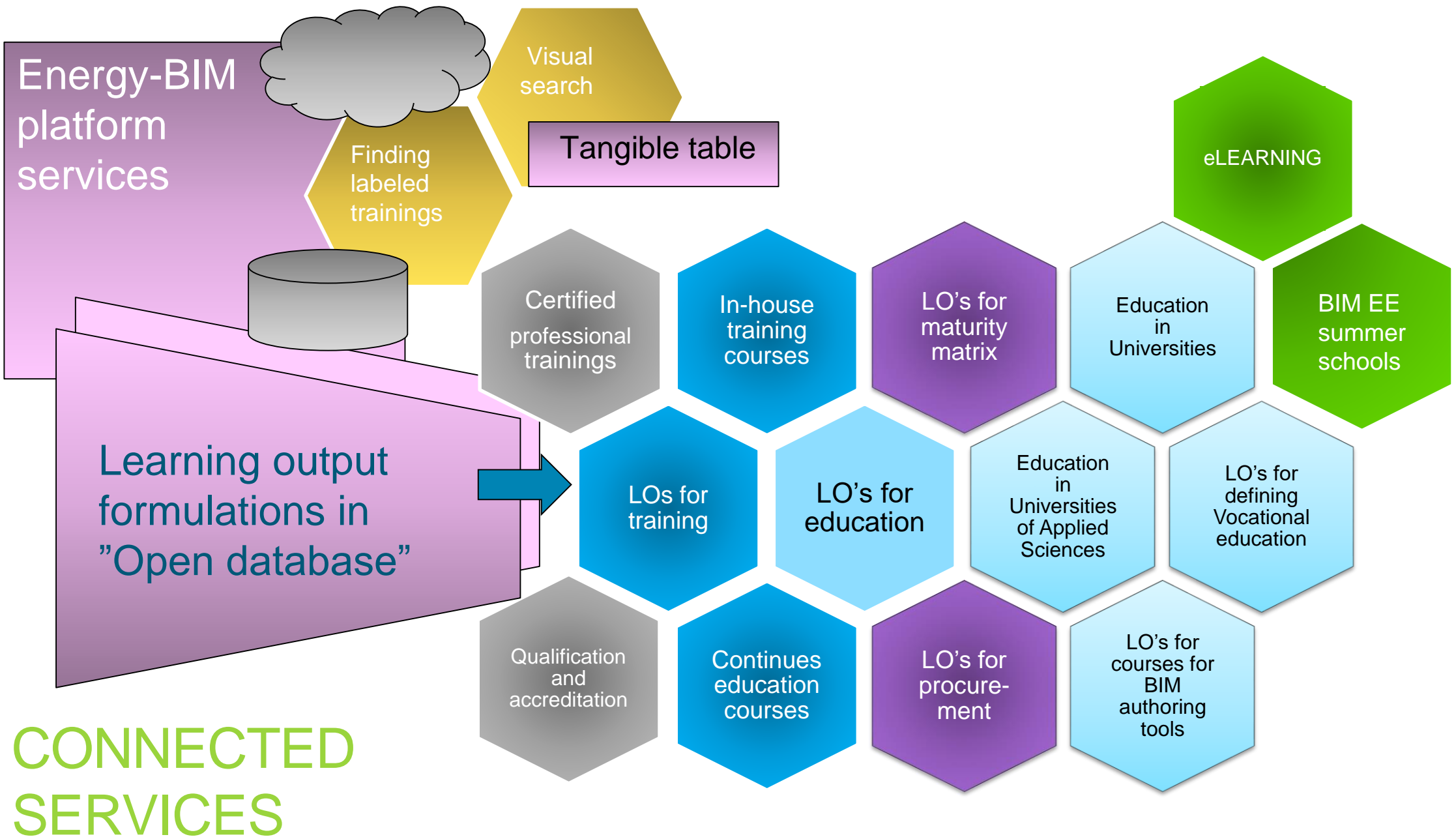




NEXT STEPS

# HOW TO USE LO'S – MULTIPLE POSSIBILITIES





# LOOKING FOR YOUR FEEDBACK

**Do you find the LOs clear and understandable?  
Is something missing?**

**Do you think LOs can support**

- planning of training and education,
- continuous education in companies and
- learning- by-doing in building projects?

**Which LO- areas are most important ones?**

**Where competence building should start and how?**